SCIENTIFIC AMERICAN SUPPLEMENT. No. 1095

Scientific American, established 1845.
Scientific American Supplement, Vol. XLII. No. 1095. NEW YORK, DECEMBER 26, 1896. Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

THE PRESERVATION OF THE PARTHENON—VIEW OF THE EDIFICE TAKEN FROM BEYOND THE COLUMNS OF PROPYLÆA.

THE PARTHENON.

THE work of preserving the Parthenon has been begun. Two years ago, during a tour through Greece, one of the most distinguished architects of France, Mr. Magne, professor in the Ecole des Beaux-Arts, had noted the condition of the edifice. The architraves were broken in places, the entire entablature unsteady; the building would certainly fall some day.

The French government reported the result of Mr. Magne's observations to the government of Greece, which immediately submitted the matter to a special commission, formed partly of Greek members and partly of foreigners residing in Athens. The members of the commission could not come to an understanding; one of them, a German, proposed to repair the edifice by putting the pieces in place and pouring cement into the interstices!

The bad feeling increased. An earthquake had loosened the entablature still more and caused the fall of several fragments of the architrave. There was no time to consider. The Greek government consulted a German architect, Mr. Durm, and an English architect, Mr. Penrose, both of whom are talented artists, and are known as archæologists. While making a study of the subject on the spot, Mr. Magne was invited by the French Minister of Beaux-Arts to prepare a plan of preservation, showing the necessary supports for replacing the blocks that had fallen or broken, and when he returned to Greece last spring he was able to present a model in wood of the scaffolding that would be indispensable for the work. He explained his ideas in a public conference; he did not consider it a question of restoration, but of preservation. There could be no question of replacing the masterpiece of Ictinus with modern work; that would certainly have been sacrilege.

His plans were accepted, and thus encouraged Mr. Magne resumed his study of the Parthenon, and was soon after able to submit to the Greek government a definite plan of work, which was officially adopted. A gang of French workmen were sent there last summer and immediately put to work. The scaffolds are in place, and the work has been begun. Mr. Magne has written a book upon the result of his observations that the Department of Beaux-Arts had edited in the national printing establishment. The water colors, photographs and drawings made by the author, which are on exhibition in the Musée du Trocadéro, have been reproduced in the book, and, together with the text, give a better idea of the edifice in its original state than anything that had ever been published. It shows such a thorough understanding of the subject that it is difficult to see how any one else could have been found who would have been as well fitted as Mr. Magne to undertake the strengthening of the ruins of this ancient structure.—L'Illustration.

ON CERTAIN PHYSICAL DIFFICULTIES IN THE CONSTRUCTION OF LARGE GUNS.*

THE substitution of forged steel for cast iron in gun construction has resulted in the universal adoption of the built-up gun. About the year 1855 the Englishman, Blakely, and the American, Treadwell, independently discovered and demonstrated the value of the principle of initial tension as a means of increasing the strength and economizing the material of a gun. What this means can be briefly shown.

Assume a tube of perfectly annealed metal with given tenacity and elasticity. If a powerful stress be applied, there is no reason why one part should be more capable of resisting it than another. Let the tube be closed at one end, and let the stress originate from within near this end, as in the explosion of a charge of gunpowder. Under this condition it was shown by Treadwell that if we assume the tube to be made up of a large number of uniform, cylindrical, concentric layers of metal, then the resistance of each layer to the exploding force will vary inversely as the square of the diameter. The stress in its effect upon the metal decreases at a rate quite similar to that of the radiation of heat or light. If the wall of the tube be under no initial stress, its inner surface may be stretched even to its elastic limit, while the stretching of the outer surface is comparatively slight. The metal's property of elastic resistance is hence not utilized to the best advantage in the outer layer, while in the inner layer it may be utilized to an extent inconsistent with safety.

Treadwell therefore proposed a plan of gun construction which has since been universally adopted. The modern gun consists of a steel tube which is reinforced by one or more concentric hoops or tubes, the number and position of these being adjusted to the variation of pressure from within as the hot exploding gas finds vent at the muzzle. The ordinates of the pressure curve are greatest at the origin, this being taken as the middle of the seat of the powder charge in the chamber. They decrease rapidly with approach to the muzzle. The reinforcement of the tube should therefore be greatest around the breech. A tubular jacket is shrunk on around the main tube, covering the breech and often as much as two-thirds of the entire length. Around the jacket is a series of compressing hoops, and around this there may be a second or outer series of supplementary hoops. Originally the interior diameter of the jacket is a little less than the exterior diameter of the tube.

By heating the jacket sufficiently it is made to expand until large enough to be slipped into place over the cold tube. This becomes enormously compressed by the subsequent cooling of the jacket. In like manner the first hoop is too small to be slipped over the cold jacket until sufficiently heated for this purpose. The same remark applies to the relation between the second and first hoops. The final result is that the diameters of the tube, both external and internal, are permanently decreased by the compression of the jacket, while those of the hoops are permanently increased. Their contractile force is not enough to compress the jacket into smaller space, for this itself is pushed outward by the powerful reacting force of the compressed tube within. The hoops, therefore, serve to reinforce the jacket by their own tendency to contract. Having been put on in an expanded condition and prevented from recovering their normal dimensions, they continue in a permanent condition of tension.

Steel is the only metal that combines elasticity and tenacity in such a high degree as to warrant its advantageous use in the manner just described. For gun metal the material should be manganese steel, made from the purest wrought iron attainable, with a very small percentage of carbon, indeed, not more than one per cent. This should be so uniformly diffused as to secure the closest possible approach to absolute homogeneity. The elastic limit should not be reached for any stress under 50,000 pounds per square inch, nor should the ultimate strength be less than 100,000 pounds per square inch. Such steel withstands a high temperature without softening, resists erosion well, and permits but little set under shock beyond the elastic limit. The preparation of such metal is a severe test of skill for the metallurgist. The most conspicuously successful gunmaker in the world, Friedrich Krupp, of Essen, Germany, uses crucible steel exclusively for this purpose.

This firm, founded by the grandfather of its present head, has made a specialty of steel and its applications in manufacture during the last eighty-five years. Bessemer, open hearth and crucible steel plants are all included in its outfit. Much the most expensive product among these is crucible steel. In its manufacture the skill of the fathers has been given to their sons, and, doubtless, grandsons and great-grandsons will continue to apply the secrets of their special art in the same place. With the staid conservatism of the laboring classes in Germany the development of heredity in artisan skill is not uncommon. In America, so restless, impatient and ambitious are our laborers, that the son rarely ever lives in the same place or works at the same occupation with his father.

So highly developed is the crucible steel industry at Essen that ingots of this metal weighing each as much as seventy tons have been repeatedly cast, and with these the forgings are made from which Krupp constructs his monster guns. Many visitors at the Columbian Exposition looked with astonishment at the great gun weighing one hundred and twenty tons, which was only one of several of the same size due to this firm. In other parts of the world crucible steel is abundantly produced for cutlery, and for small articles generally where the finest quality is demanded. But nowhere else than in Essen has the highest grade of crucible steel been made thus far in quantities sufficient for the largest forgings. In England, in France, and in America gun metal is at present made by the open hearth process. While this product is greatly superior to Bessemer steel, the method of production is such as to forbid the attainment of such nearly perfect homogeneity as can be secured by the more expensive crucible method.

The open hearth steel used for our largest American guns is produced for the most part, if not entirely, at Midvale and Bethlehem, in Pennsylvania. Before actual use test specimens are required to manifest tensile strengths from 75,000 to 125,000 pounds and elastic limits from 40,000 to 70,000 pounds per square inch, according to the caliber of the gun and the special parts of this for which the metal is intended. For tubes, jackets and hoops the maximum tensile strength demanded is 93,000, and the maximum elastic limit, 53,000 pounds per square inch.

Up to ten years ago American fortifications were for the most part supplied with nothing superior to the Rodman cast iron smooth bore columbiad and Parrott rifle, the latter being made of cast iron, but reinforced with a wrought iron hoop. During this interval Congress has appropriated about $20,000,000 for the modernizing of our navy and our seacoast defenses. For the latter the largest built-up steel rifle thus far constructed has been one of 12 inch caliber, 40 calibers in length, weighing 57 tons. This is not yet ready for use. A 16 inch rifle, very nearly as massive as the great Krupp gun, has been ordered and will probably be finished within the next two or three years. A number of 12 inch 34 caliber guns have been finished, tested and mounted.

In assembling the parts of the large 40 caliber gun at the Watervliet Arsenal gun shop a few months ago, an unfortunate mishap occurred. After the tube had been reinforced near its forward end with a series of hoops it was prepared for the more formidable work of shrinking on the large jacket. It was stood up vertically upon the breech end, and the heated jacket was let down into position. The heating proved to be insufficient to secure all the expansion needed, and as a result the cooling jacket gripped the tube before quite reaching the final position intended. An interesting problem was now presented, that of separating the tube and jacket after they had become thoroughly cool, and completing the process which had been so unexpectedly interrupted.

After due consideration the plan which seemed most promising of success was to introduce the cold gun, with breech downward, as suddenly as possible into a furnace, protecting the exposed part of the tube below the jacket from the heat by inclosing it in a bag of asbestos cloth through which a strong blast of cold air should be propelled. The jacket being thus heated first, while the tube within was comparatively cool, it was hoped that expansion enough might be attained to insure separation. In order to keep the greatest possible difference of temperature between jacket and tube, a flow of cold water through this was set up immediately after its emplacement within the furnace. The breech had been closed watertight. A pipe occupying the axis of the bore was coupled at the top with hose from an elevated tank full of ice water, and this was carried thus to the bottom. After it had filled the tube it was carried off by an overflow pipe. The jacket, or certainly its lower part, was quickly raised to a temperature estimated to be about 1,100° F. The temperature gradients from outer to inner surface would obviously be curves, at first sharply concave upward, but gradually approaching straight lines as the heating continued. It was hoped that, before the equilibrium expressed by the straightening of these gradients should set in, the jacket would become expanded enough to settle down by its own weight into the desired final position.

But this hope was doomed to disappointment. The external heating and internal cooling was continued nearly eight hours on January 27, the flow of ice water being kept quite uniformly forty cubic feet per minute. Its temperature was raised from 34° to 40° F. in transit, with but little variation after the first two hours. The water was then discontinued and the supply of heat kept up through the night. On the following day the experiment was renewed, but varied by trying the effect of sudden cooling from within. On admitting the supply of ice water there was naturally much steam produced at first, but within fifteen minutes the temperature difference between inflow and outflow fell to 36°. At the end of two hours it had fallen to 9°, and during the remaining six hours it continued quite uniformly about 8°. This difference was in excess of that of the previous day, as it had been found necessary to reduce the rate of water supply. This experiment being unsuccessful, the gun was removed from the furnace and allowed to cool.

The furnace had been originally constructed of such dimensions as to permit of heating the longest jacket, but not an entire gun. Since the breech and unjacketed part of the gun under present conditions had to occupy space within the furnace, an extension of this at the top had to be improvised to inclose the upper part of the jacket. Soon after the experiment began it was observed that the heating was by no means uniform, and by no supplementary efforts could uniformity be secured.

Measurement upon the cooled gun revealed the fact that the jacket had changed its position nearly half an inch, but this was only one-twentieth of the shifting needed. It was not surprising also to find that the whole assemblage was perceptibly warped.

The method, applied on so large a scale and under conditions which had precluded the possibility of uniform heating, had failed. But theoretically it seemed unassailable. It was decided to test it again under more favorable conditions. The construction of a new large gun for this test would obviously involve an unwarranted expense; for the cost of a completed 12 inch gun of this type is not much less than $60,000. A short "dummy" gun was therefore constructed of 8 inch bore and 3 feet in length. This was provided with hoop and jacket, which were shrunk on tightly into position, a special furnace being built for the purpose of the experiment. The piece was inserted into the hot furnace, the water turned on to the interior, and at the end of 3 minutes the jacket suddenly dropped 4 inches. It continued then creeping downward at a moderately uniform rate, and dropped entirely off from the tube at the end of 42 minutes 30 seconds. The temperature of the inflowing water was 58° F. and that of the outflow 67° F., no attempt being made to secure artificial cooling by use of ice.

The success of this experiment, which was made on March 31, caused the decision to make another trial with the large gun. This was started on May 11, extra precautions being taken to secure uniformity of heating. An auxiliary grate had been prepared for the furnace extension above, and with a view to securing the highest heat as close to the jacket as possible, baskets of heavy netting were filled with charcoal, inserted in the furnace and brought close up around the gun after its insertion. At the same time water at a temperature of 68° F. was turned on, as it had been found impossible to secure a sufficiently rapid supply of ice. The elevation of temperature in transit was at first 5° F., and this rose in time to 11° F. At the end of 22 hours 30 minutes, the jacket having remained immovable, the fire was drawn from the furnace, while the water supply was continued 15 hours longer, until the gun was thoroughly cooled.

It is but due to say that, although this experiment has proved an instructive failure, the gun is not lost to the ordnance department of the government. The unjacketed part of the breech will be cut off, and the final outcome will be simply a gun somewhat shorter than provided for in the original specifications.

But the question may be asked, Will this gun be so reliable as it would have been without passing through so many fiery ordeals? After each furnace trial it was carried back to the shop and the degree of warp ascertained by measurement. Its exact condition between the locking of the jacket and the first attempt to move this is not known. The present warp of the axis between the breech end and the support near the muzzle end of the jacket is 0·1855 inch, and from here to the muzzle end of the gun, 0·1561 inch in the opposite direction but in the same plane. Between the first and second attempts at removal there was no noticeable variation of result. The interior diameter of the bore within the jacket has been decreased, as might be expected: but this decrease is quite irregular, reaching a maximum of 0·064 inch about two feet from the upper, or muzzle, end of the jacket, while at the other end of the jacket it is 0·017 inch. The diminution of bore extends to the extremity of the breech beyond the region of compression due to the jacket.

The only hypothesis upon which these irregularities can be even tentatively explained is lack of homogeneity in open hearth steel. The better the steel, the more near perfectly does it recover from strain after the removal of stress. Irregularity in heating during the first attempt would have produced warping in any metal whatever. Perfectly homogeneous steel would have recovered completely when the temperature became uniform, but any lack of homogeneity implies a permanent set. Assuming such lack, the larger the scale of experiment, the more difficult it is to secure uniformity of temperature. The steel may satisfy completely the demands of preliminary test experiments on elastic limit and tensile strength, yet it may fail to meet the requirements of accurate fitting and complete recovery after wide variation of temperature. Krupp, with his admirably homogeneous but high priced crucible steel, has already been successful in assembling the parts of guns twice as massive as the recent subject of experiment at Watervliet. It remains to be seen whether equal success will be possible by the use of open-hearth steel in connection with the 16 inch gun yet to be constructed. In the light of recent difficulties the approaching work will be watched with interest.

The publication of these observations in the present form would not have been possible but for the friendly courtesy of Major Isaac Arnold, Jr., the commandant of the Watervliet Arsenal, who has granted me the utmost freedom of access to the gun shops and who kindly invited my interest and co-operation in the attempt to solve the problem of the unmanageable jacket.

W. LECONTE STEVENS.
Rensselaer Polytechnic Institute, Troy, N. Y.

* From Science.

ENGINEERING NOTES.

The Bechuanaland Railway has been finished for a distance of 162 miles beyond Mafeking, and earthworks are in progress to a distance of 230 miles, says the Times correspondent. It is hoped that 220 miles will be finished by the end of the year. The difficulties are enormous, owing to the drought. The engineers are conveying 25,000 gallons of water daily from Mafeking for the use of the engines and men.

Rapid progress is being made with railways in Rhodesia. The line starting from Fontesville toward Salisbury, commenced in 1892—72 miles—was no sooner finished than another contract for 118 miles on the road to Salisbury was let, covering the tetse fly district. Since then the Fontesville-Beira Railway has been commenced, and the Mafeking and Buluwayo Railway is now well in hand.

The French Transatlantic Steamship Company are arranging for the construction shortly of three new steamers for the Havre and New York service. The three new ships will be a great advance on La Touraine, and consequently improvements are to be made in the harbor and docks. In view of this large scheme it is said that the French government is to be approached with the view of the existing subsidies being continued after 1901, when the contract lapses.

The record of railway accidents in the United States in September includes 45 collisions, 64 derailments and 7 other accidents, a total of 116 accidents in which 54 persons were killed and 179 injured. These accidents are classified in the Railroad Gazette as follows: Collisions—Trains breaking in two, 9; misplaced switch, 4; failure to give or observe signal, 4; mistake in giving or understanding orders, 5; miscellaneous, 4; unexplained, 19; total, 45. Derailments — Defective bridge, 1; defective track, 1; broken wheel, 2; broken axle, 10; broken drawbar, 1; air brake pipe, 1; misplaced switch, 7; careless running, 2; runaway, 1; landslide, 1; malicious obstruction, 5; accidental obstruction, 2; unexplained, 30; total, 64.

Mr. J. D. Weeks has just made a report, says the Railroad Gazette, on the supply of natural gas and its decline, from which it appears that the supply has fallen to half in seven years. In 1888 the value of the gas produced was $22,629,875. In 1895 it was $13,006,650. In Pennsylvania the fall has been much greater than in Ohio and Indiana. In 1888 the gas produced in Pennsylvania was worth $19,282 375; in 1895 it was $5,852,000. The decrease has been less rapid since 1891, owing to the general introduction of meters, but it has gone on at the rate of about 5 per cent. a year. As the product shrinks rapidly when pressure falls, it may not be over ten or fifteen years before very little gas is produced.

Les Chemins de Fer d l'Est, France, are rather proud, says The Engineer, of a feat which was recently performed at their works at Epernay—the erection of a locomotive in 107 hours. In commemoration of this feat they have issued an interesting pamphlet containing nine large photogravure plates representing the progress made with the engine at the end of 1 hour, 10 hours, 30, 40, 60, 70, 80, 100, and 103 hours respectively. In issuing this pamphlet the company is aware that locomotive engines have been erected in less time in this country and in the United States, and makes no pretension to holding the record, but maintains that allowance must be made on account of French locomotives being more complicated in design than others. It may interest our readers to know the hours worked by the different groups of tradesmen employed on the work: Erectors, 158 hours; erectors' apprentices, 305 hours; machinists, 220; machinists' apprentices, 224 hours; riveters, 174 hours; riveters' apprentices or holders up, 58 hours; tube hands, 221 hours; and boys, 93 hours.

The Walrand-Legenisel steel process is meeting with considerable success in Europe, according to a paper read by Mr. George J. Snelus at the recent meeting of the Iron and Steel Institute of Great Britain. It has been adopted by two firms in France, two in Germany, two in St. Petersburg, Russia, one in Spain and one in Glasgow, Scotland, one in Erith, England (Frazer & Chalmers), and one in the United States (Potter & Hallis, Chicago). The size of the converters range from 350 kilos to 1 ton. The principal field for the process is for steel castings, which are made solid and very true to pattern, the melted metal being unusually fluid. It is also applicable to the manufacture of special steels which are required in smaller quantities than can be conveniently produced in the ordinary converter or in the open hearth. It differs from the ordinary Bessemer process in the addition of ferro-silicon to the metal in the converter at approximately the time of flame drop, and making an after blow. The rapid combustion of the silicon raises the temperature most notably, and finishes the process by burning silicon to a solid (slag) instead of carbon to a gas.

A paper recently read in America on heat conductivity, expansion, and fusibility of fire brick, by Mr. J. D. Pennock, gives notes of experiments on bricks made of Greek and of American magnesite, silica brick, and coke oven tiling made in Belgium. The analyses of the respective materials were as follows: Silica—Greek magnesite, 2·16; American magnesite, 3·10; silica brick, 94·07; coke oven tiling, 69·89. Iron oxides and alumina—Greek magnesite, 0·72; American magnesite, 6·64; silica brick, 3·66; coke oven tiling, 27·75. Calcium oxide—Greek magnesite, 4·20; American magnesite, 3·76; silica brick, 1·39; coke oven tiling, 0·27. Magnesium oxide—Greek magnesite, 93·03; American magnesite, 86·50; silica brick, 0·19; coke oven tiling, 0·17. The weights per cubic foot were for the Greek magnesite, 170·2 lb.; American magnesite, 160·9 lb.; silica brick, 111·4 lb.; coke oven tiling, 109·9 lb. In experimenting on heat conductivity, the different brick showed, after exposure in the furnace for five hours, starting at 25°, the following temperatures: Greek magnesite, 337°; American magnesite, 297°; silica brick, 177°; coke oven tiling, 154°. This shows the superior conducting power of the magnesite. The expansion per foot under high heat was for the Greek magnesite, 0·11 in.; American magnesite, 0·088 in. to 0·10 in.; coke oven tiling, 0·076 in.

ELECTRICAL NOTES.

The Chilean government telegraph lines now comprise about 7,500 miles.

The report of the nineteenth convention of the National Electric Light Association, just issued, contains a description, with diagram, of the method employed last May to operate a small motor at the New York Exposition by current generated at Niagara Falls. Two Western Union telegraph wires and the ground served to transmit the energy, the power developed in New York being about one-thirtieth of a horse power.

The English Electrical Review gives a brief account of a process devised by Pinto, in which meat is preserved by immersing it in a 30 per cent. solution of common salt and passing a continuous current of electricity through the solution for 10 to 20 hours, after which the meat is dried; 1,000 kilogrammes of meat required a bath of 3,000 liters and 100 amperes at eight volts, the electrodes being platinum. Details of the process are lacking.

The Electrical Engineer says: "A new kind of bicycle race recently took place at Norway, Me. A board track 100 feet long and eight inches wide was built and electric wires strung, with twenty-one buttons scattered along the length of the path. The contestants rode the narrow track, and in passing ran over the buttons wherever possible. The winner managed to ring eleven of the twenty-one bells."

In a paper read before the British Association meeting, says the Electric World, Mr. John Burke stated that he had determined, with the aid of a double slit photometer and also photographically that fluorescent bodies such as uranium glass absorb more light when fluorescing than when not. Uranium glass is therefore less transparent to the light of the candle in the daylight than it is in the dark. In other words, the absorption coefficients are altered during the fluorescence for the particular rays the bodies emit.

Pacific coast exchanges contain records of the filing throughout that region of locations for water rights with the development of electric power as the chief object in view, says the Engineering and Mining Journal. It is reported that a contract for a very large power transmission plant at Blue Lakes, California, has been awarded to the Stanley Electric Company, of Massachusetts. Santa Barbara, Cal., has just had its first experience with an electric road. Crude petroleum obtained at Sommerland, eight miles away, is the only fuel used in the power plant. It costs 2¼ cents per gallon delivered.

President Baldwin and other officials of the Long Island Railroad have been considering for months the feasibility of electricity as a motive power, and are convinced that old-fashioned locomotives can now be supplanted by electric motors. It is not intended to use the motors to run to distant points of the island, but to nearby places, such as Jamaica, Flushing, Mineola, Far Rockaway, College Point and Manhattan Beach. President Baldwin says: "There is no doubt that the motors have arrived at such a stage of perfection that they can be used with benefit to our patrons and the road. We will go slow in the matter, because simplifying improvements are being made every day, and we want the best in the market. I think some of the motors will be in operation next summer."

A railroad without a Morse telegraph instrument in any of its stations or offices, not even the most important, is an uncommon sight, so much so, says the Railroad Gazette, that most railroad men would call it a curiosity; but such, it appears, is to be the character of the new Queen Anne's railroad, extending southeastward from Baltimore across Maryland and Delaware, east of Chesapeake Bay. The road is about fifty miles long, and it is intended to use the telephone for all communications for which a letter by train would be too slow. The use of the telephone for all necessary instantaneous communication is not entirely unknown in the United States. Mr. C. A. Hammond described in the Railroad Gazette, several years ago, the practice on the short Boston, Revere Beach and Lynn road, where train orders were sent by telephone and perfectly satisfactory written copies and records were made. The Suffolk and Carolina road, extending forty miles southward from Suffolk, Va., has depended on the telephone for ten years. It is fair to say, however, that the number of train orders issued on that road is not very large. Only two regular trains are shown in the Official Guide, and the leeway at the meeting point is eight and one-half hours; that is to say, the north bound train meets itself at the northern terminus, arriving at 9 A. M. and going back at 5:30 P. M.

The application of electric motors for the driving of machinery in ship yards and engine works promises to extend rapidly, thus providing an additional factor in the acceleration of the already rapid rate of production in these branches of industry, says the Western Electrician. Such motors have already been adopted to some extent in several of the largest Clyde yards and engine shops, and in one or two on the northeast coast of England. The rapidity of the work which has been done recently on several British battleships has been remarkable, and has been mainly due to the employment of electrically worked drills, slotting machines and other apparatus of a kindred nature. The application of electricity, however, has not in England assumed anything like the dimensions observable in German workshops and ship yards. At the Berlin Machine Works, for example, says the Marine Review, the tools and machines employed, which are of the latest patterns, are worked by motors, which receive power from a central station. In the ship and engine works of Blohm & Voss, Hamburg, which have been mostly rebuilt and reorganized within the last few years, there are electrically driven hoists alongside the building berths, electric (combined with hydraulic) power traveling cranes throughout the engine and boiler shops, and clever applications of the principle to various other machine tools. At the present time preparations are going forward for the laying down of a new ship yard at Nikolaiev, Russia, the machinery for which, it is said, is to be almost entirely electrically driven, and is being made in Germany, Belgium and France.

MISCELLANEOUS NOTES.

The Paper Digest contemplates the opening of a chemical laboratory for the purposes of testing paper, and will have sanie in charge of a thorough, practical chemist. Preparations are now being made for the chemical equipment of this testing bureau.

Experiments to test the relative efficiencies of plain and ribbed glass have shown most conclusively that much more light is thrown into the darkest corners of rooms when ribbed glass is used. It would appear that the corrugations disperse the light thoroughly, and cause a more general diffusion of light than plain glass.

A correspondent of the Papier Zeitung sends a graphic communication relating to the pursuit of printing and book binding in all its branches in certain convents of Northern France. As a matter of fact, the paper is made with the water mark of the order, the book printed, bound, and completely finished on the premises. Even the art of illustrating, from wood engraving to photogravure, is thoroughly mastered by the monks, the products, chiefly religious books, being scattered all over the world, from Madagascar and India to China and New Zealand.

Twenty-three colleges in the United States were founded before the beginning of this century. These are: Harvard, 1636; William and Mary, 1693; Yale, 1701; University of Pennsylvania, 1740; Princeton, 1746; Washington and Lee, 1749; Columbia, 1754; Brown, 1764; Rutgers, 1766; Dartmouth, 1769; Hampden-Sidney, 1775; Washington (Md.), 1782; Dickinson, 1785; Charleston, 1785; University of Georgia, 1785; University of Nashville, 1785; Georgetown, 1788; St. John's (Annapolis), 1789; University of Vermont, 1791; Williams, 1793; Granville and Tusculum, 1794; University of North Carolina, 1795; Union, 1795; and Washington (Tenn.), 1795.

Bradstreet's states that the total number of failures of firms, corporations, and individuals in commercial, financial, and industrial lines in the United States during the past nine months is 11,280, the largest aggregate for a like period since records of this character have been compiled, the next largest total having been in the corresponding portion of 1893, 11,140, five months of which were marked by panic. The record for 1896, at the close of its third quarter, showed 11,280 business failures, $171,350,000 of liabilities and $99,613,000 of assets, an increase as compared with the corresponding portion of 1895 of 21 per cent. in the number of failures, 56 per cent. in gross liabilities, and 63 per cent. of actual assets, an unusually large proportion.

An exhibition to celebrate the centennial of the invention of lithography was given in the Lexington Avenue Opera House, New York City, recently, the proceeds being devoted to the erection of a monument to Senefelder, the inventor of the process. There were many hundreds of exhibits, including the first lithographic stone made by Senefelder one hundred years ago, the subject being the quarry from which the stone was taken at Salnhofen. There was also the largest stone ever made, which was imported from the same quarry a month ago. Souvenir lithographs were printed at the exhibition and handed to visitors from the press. All the lithographic shops in New York and Brooklyn closed one day so that their employes might properly celebrate the centennial.

Cracks in articles made from rubber are said to be due to the oxidation of the caoutchin, the essential oil of caoutchouc. A writer in the Indian Engineer says that vulcanization does not lessen the affinity of this substance for oxygen. The compounds used tend to fill the pores of the rubber, and thus somewhat reduce the opportunity for oxidation; but the metallic oxides and other substances introduced in vulcanization and dyeing—including sulphuric acid from antimony sulphide—are often injurious, and boiling in caustic soda to remove the "bloom" left on goods by an excess of sulphur may cause injury. A comparison of analyses of the damaged rubber with those of articles that are sound shows a very large increase in the percentage of oxygen and some loss of carbon and sulphur. The hope is expressed that rubber may be produced synthetically ere long, thus removing our dependence on the precarious source of supply.

A French officer has invented a new projectile for firearms which is said to wound and kill as well as the usual bullets, but does not possess the ravaging action of the present projectiles of repeating rifles. The new missile is not of metal, but of paper surrounded by a thin shell of aluminum. According to the inventor, the paper bullet, fired at the same distance, under the same circumstances, and with the same precision as the ordinary bullet, produces a thoroughly smooth wound. The number of disabled soldiers would be no less if the projectile of the future were to be the paper bullet, but the number of the dead and fatally wounded would be considerably in the decrease, as many a shot fired with a steel projectile would produce a deadly wound, whereas the paper bullet is said to only bring on a curable injury. The inventor has sent his bullets for approval to all the governments belonging to the convention of Geneva, and the Austrian war office has ordered trials to be made of the invention.

The ambassador of the United States in China has reported to the State Department at Washington that a commercial museum has been established at Pekin. It appears that the university of that town has recently, under the guidance of the American Methodist Mission, opened a museum in one of its buildings, which is destined to exhibit foreign machinery and sundry mechanical appliances. The visits to the museum on the part of the better class of the population are increasing daily, and the visitors are almost exclusively people who seem anxious to study foreign inventions and industrial productions. The president of the museum solicits models, photographs, or tracings of machinery, and inventions or patterns of the same, especially plows, ships, muskets, cannon, electrical machines, carriages, locomotives, windmills, weaving looms, printing presses, etc. According to the Chamber of Commerce Journal, the samples or patterns sent in will be provided in the Chinese language with the names and addresses of the exhibitors, also with a description and price of the article if desired.

SELECTED FORMULÆ.

Ink for Glass and Metals.—For making microscopic and other glasses and bright metallic surfaces, Schobel recommends the following ink in the Central Zeitung fur Optik und Mechanik: 1 or 2 parts of sodium silicate, and 11 parts of liquid Chinese ink give a black; 3 or 4 parts of sodium silicate, 1 part of Chinese white or of sulphate of barium, a white. The mixtures are to be kept in well corked bottles and must be shaken before use. It writes with a steel pen, which should after use be wiped. The writing is not absolutely proof against all reagents, but almost so; it can easily be erased with a knife.

Kola Wine.—

Kola nuts (roasted)	1 oz.
Essence vanilla	1 dr.
Sirup	2 oz.
Sherry wine to make	1 pt.

Bird Manna.—

Almonds	1 lb.
Pea meal	2 "
Butter	3 oz.
Saffron	10 gr.
Honey	q. s.

Beat the ingredients together in a mortar, then rub through a coarse sieve to granulate and dry.

Brown-Sequard's Mixture.—

Sodium bromide	180 gr.
Potassium "	180 "
Ammonium "	180 "
Ammonium iodide	90 "
Potassium "	90 "
Ammonium carbonate	60 "
Infusion of calumbate	8 oz.

Shampoo Paste.—

Castile soap	4 oz.
Potassium carbonate	1 "
Glycerine	½ "
Water	6 "
Oil of bergamot	15 m.
Oil of rose	5 "

Heat the soap, pot. carb. and water on a water bath, stirring occasionally till a cream is produced, then add the oil and glycerine.—Canadian Pharmaceutical Journal.

Essence of Rennet.—For three stomachs, dried, take of—

Salt	15 ounces
Boric acid	6 dr.
Alcohol	15 ounces
Water	150 "

Cut the stomachs into small pieces, and macerate for an hour in 50 ounces of water in which 5 ounces of salt have been dissolved. Strain through muslin and repeat the maceration with the same quantity of solution. Dissolve the boric acid in the liquid, add the spirit and filter through a double filter paper with a small quantity of kaolin.

Keeping Machinery Bright.—The following mixtures are proposed in Neueste Erfindungen und Erfahrungen for the purpose of preserving a good polish on iron and steel and parts of machines in general. In a corked bottle, 30 parts of petroleum are mixed with 1 part of paraffin, the mixture is applied by means of a rag or a brush and rubbed well the next morning with dry wool. The other mixture is more complicated. Five parts of oil of turpentine, 25 parts of stearin, 25 of polishing red, and 25 of animal charcoal are stirred into spirit and well shaken until a homogeneous liquid mass has been obtained. This is applied with a brush, and the spirit allowed to evaporate. The surface is then rubbed with a mixture of 25 parts of red and 45 parts of animal charcoal.

Artificial Lime Juice.—Artificial lime juice is usually prepared by dissolving citric acid in water and flavoring with oil of limes or oil of lemon. The following formula is after Hager:

Citric acid	70 grammes
Distilled water	850 "
Oil of lemon	0·7 "
Alcohol	80 "

Dissolve the acid in the water and the oil in the alcohol, and mix the two solutions.

The following makes a very excellent substitute for genuine lemon juice:

Powdered citric acid	256 grains
Tincture of lemon peel	6 drachms
Distilled water, to make	8 ounces

—Pharmaceutical Era.

A. Gawalowski recommends the following treatment for files that have been in use for some time: Lead and tin are best removed by nitric acid; the files are then dried in coaldust or sawdust, after which they receive a good brushing. Iron grit is removed by dipping into copper sulphate; the precipitated copper does not adhere. Treatment with nitric acid follows, which is, as in the former case, continued until the brown vapors become unpleasant. Zinc is dissolved out by sulphuric acid. For copper, nitric acid is repeatedly applied. Rasps are cleaned in warm sulphuric acid, brushed, dipped into caustic soda and dried and brushed. The drying can be quickened by pouring spirits over the files and lighting the spirits. To a certain extent these cleaning processes will effect a sharpening. We reproduce these hints after the Allgemeine Technische Verein.

Moth Paper.—

(1)	Carbolic acid	1 ounce
	Ceresin	1 "
	Naphthalin	2 "

Melt, immerse pieces of bibulous paper, and dry these on plates.

(2)	Carbolic acid	1 ounce
	Camphor	1 "
	Benzin	to make 1 pint

Saturate pieces of blotting paper and apply, or use the liquid in the form of spray by means of an atomizer.

THE RESISTANCE OF PNEUMATIC TIRES TO ROLLING.

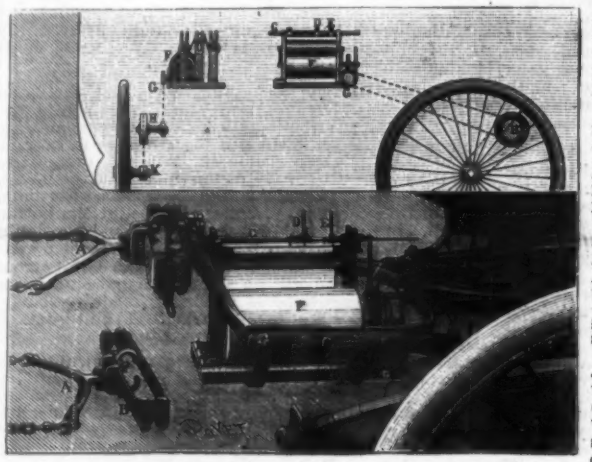
PNEUMATIC tires, which have been the principal factor in the rapid development of cycles of all kinds, have, in a measure, a tendency at present toward being more widely used and toward finding a new application upon the wheels of carriages properly so called. In fact, we are already meeting with a certain number of vehicles—horseless and otherwise—the wheels of which are provided with such tires, and it is, therefore, of interest to inquire whether or not, aside from the evident advantages that they present as compared with the ordinary iron tires, and as regards smoothness of rolling and suppression of noise, they have the effect of diminishing the resistance to rolling and of reducing, by so much, the work of the mechanical motor or of the animal that draws the carriage.

This question has been examined by Mr. Michelin, who, to this effect, has made some remarkable comparative experiments, the results of which are recapitulated in an interesting memoir presented by him to the Society of Civil Engineers, and the most characteristic data of which we herewith reproduce.

In the first place, Mr. Michelin observes that the idea of using pneumatic tires is much older than is generally thought, since, in 1847 and 1849, Mr. Thomson, an English inventor, patented and constructed various types of such tires, some of which were nearly identical with those that are now employed. There was one type especially that embraced an air chamber of pure rubber or rubber cloth, and strengthened upon the rolling part.

At that date carriages were constructed that were provided with these new tires, and that were even submitted to dynamometric experiments for the purpose of ascertaining the resistance that they presented as compared with vehicles provided with iron tires.

In his memoir Mr. Michelin reproduced an extract from the Mechanics' Magazine of March 27, 1847, relative to an experiment that had just been made in London upon a track formed for the purpose in Regent's Park. A carriage provided with pneumatic tires and weighing 1,050 pounds, running at the speed of nine miles an hour upon a macadamized road, required a tractive stress of but twenty-eight pounds, while with iron tires such stress reached forty-five pounds. The saving thus effected, therefore, represented thirty-eight per cent. Upon a road covered with newly broken stones the advantage was still more perceptible, since the stress developed descended to thirty-eight and one-half pounds, instead of one hundred and twenty.



THE MICHELIN APPARATUS MOUNTED ON A PNEUMATIC TIRED WHEEL CARRIAGE.

The editor of the journal, in reproducing these results, states that they were a great surprise to him, since he at first considered that, as frictional stress is always less with hard substances, wheels with iron tires ought, in this respect, to present an evident superiority as compared with those provided with rubber tires.

To this theory one of the readers of the Revue Technique very judiciously objected that the stress thus studied was not a friction like that which is developed between the axle and its bearing, but, on the contrary, a resistance to the rolling between the wheel and the ground, and which is especially increased by all the inequalities of the roadbed, and has the effect of causing a series of vibrations that uselessly absorb a large part of the work expended. Such vibrations are very perceptible with heavy springless carriages and are very much reduced with suspended ones, but the interposition of the rubber tire produces the same reducing effect under the most advantageous conditions, since it protects the entire carriage against the vibrations that an unevenness of the road would otherwise produce, its perfect elasticity permitting it to adapt itself to inequalities through a series of continual distortions that, so to speak, absorb but an insignificant useless effect.

This explanation well showed the interest that is attached to the prevention of shocks in the traction of vehicles in order to reduce the motive stress as much as possible. It was confirmed later on by Prof. Marey, who pointed out the advantage of employing spring traces in the harnessing of animals to vehicles.

The interposition of an elastic material has an equally favorable influence in both cases, since it spares both the vehicle and the motor, and even the roadway, inasmuch as the roadbed is so much the more easily preserved in a good condition in proportion as we succeed the better in getting rid of all the continual shocks.

We shall not revert to Mr. Marey's experiments, but shall confine ourselves to the researches made by Mr. Michelin for the purpose of determining the value of the tractive stress upon vehicles.

The accompanying figure gives a view of the apparatus employed to this effect by Mr. Michelin. It is, as he observes, a dynamometric spring formed of two bands, B, jointed at their extremity and fixed, one of them, to the singletree and the other to the body of the carriage.

The flexions of the spring are inscribed upon a band of paper whose motion forward is brought about by the very displacement of the carriage.

The figure shows the details of the intermediate parts employed for this purpose.

A toothed wheel, K, keyed upon the front axle, transmits, through an endless chain, the motion of this axle to an intermediate one, H, fixed to the carriage body and interposed for the purpose of obtaining the requisite reduction of speed. This axle in turn carries along, in a parallel manner, the wheel, G, and, through the latter, an endless screw that gears with a pinion mounted upon the axis of a cylinder that is covered with emery cloth and that, through friction, actuates the roller, F, around which the paper is wound. Before reaching this point, the paper, starting from its roller, passes around an intermediate one whereon it is stretched and receives the inscription of the stresses. To this effect, three pencils are employed, the first, C, and second, E, of which are connected with the cheeks of the apparatus and remain fixed at an invariable distance, while the third, D, is attached to a rod actuated by the fork of the singletree and is thus carried along through the flexion of the dynamometric spring. A small counter spring, on another hand, prevents the deflections of this third registering pencil. The position of the latter is carefully fixed at the start, before the carriage traces are hooked, in such a way as to constitute the line of nullity of stress that is always maintained at a constant distance from the lines made by the two fixed pencils. As soon as the motion begins, the stress developed by the horse causes a flexion of the spring and a corresponding displacement of the movable pencil. A curve whose ordinate measures the mean stress exerted is thus obtained for the trip studied.

The apparatus thus arranged was installed upon a well suspended pleasure carriage that served as an experimental one, and five series of comparative trials were made in operating with each series upon roads of a different nature, an endeavor always being made to have the conditions as identical as possible.

The vehicle employed weighed 1,270 pounds when mounted upon wheels with iron tires and 1,190 when mounted upon wheels with pneumatic ones. The iron tired wheels of the fore carriage were 3 feet in diameter and weighed 127 pounds and those of the hind carriage were 3·6 feet in diameter and weighed 158 pounds. The pneumatic wheels weighed respectively 85 pounds with a diameter of 3 feet in the fore carriage and 123 pounds with a diameter of 4 feet in the hind carriage.

The first series of experiments was made in January, 1895, upon ground that was first covered with snow and that was afterward very muddy. The second series was made in August, 1895, in operating upon various roadways, macadamized or paved, and under the same conditions of dryness.

In a third series, effected in November, 1895, an endeavor was made to still further vary the nature of the ground. The carriage was operated upon short and exactly limited lines with regular and irregular gradients. A comparison was made between solid rubber, pneumatic and iron tires.

A fourth series of experiments, made in January, 1896, served to verify the results of the preceding experiments. The diagram obtained in this series shows, in general, that the pneumatic tire required a tractive stress less than that required by the iron ones, and that the saving thus obtained was greater in a trot than in a walk, this being due to the fact that the stress absorbed by the pneumatic tire remains sensibly constant in a trot as well as in a walk, while in the case of iron tires it increases with the speed.

As the speed reached up to this time had never exceeded about 6¼ miles an hour, the experiments were resumed with an elongated trot in a fifth series of experiments, with an endeavor to realize a speed of 9 miles an hour.

Here again the stress absorbed by the pneumatic tire was not affected by the speed reached, and kept quite constant.

An examination of the diagrams at once showed the superiority of the pneumatic tires, but it was also seen that the advantage was not the same with the solid rubber, since the ordinate corresponding to the stress absorbed in this case kept constantly in the vicinity of the iron tired wheels, and sometimes even above it.

These results may be recapitulated by saying that with the pneumatic tire the stress upon a regular macadamized road reached, as a general thing, 29 pounds in a walk, say at a speed of 3 miles an hour, and but 29¾ pounds in an ordinary trot corresponding to a speed of 6¼ miles an hour, as well as a quick trot corresponding to 9 miles.

With iron tired wheels, on the contrary, it is possible to obtain 29 pounds in a walk, 37 in an ordinary trot and 48 in a quick trot. This clearly shows that the advantage of the pneumatic tire increases with the rapidity of the gait.

On another hand, as regards comfort, Mr. Michelin observes that wheels provided with the pneumatic tire have the advantage of surmounting obstacles without causing any shock to the carriage, since it flattens in front and behind and gives a wide bearing surface that corresponds to a relatively feeble pressure per square inch, so that the wheel passes without crushing anything, while the iron tired wheel is forced to rise during the passage, remains upon the obstacle, which it often crushes, and falls back again upon the ground with a shock. It therefore causes a series of disagreeable vibrations and stresses, annexed or uselessly absorbed by the crushing of the inequalities of the road.—La Nature.

A new source of tannin, the "Pyinkado" tree, which grows in Burma, is reported in an Indian contemporary. It is known scientifically as Xylia dolobriformis. It is compared with cutch, which Dr. Watt says yields from 42 to 55 per cent. of tannin. Hundreds of tons of pyinkado bark and sawdust are annually carted away as refuse from the saw mills in Burma.

A NEW UNIVERSAL HIGH SPEED STEAM ENGINE.

IN the engine herewith illustrated there is no part which, according to the Engineer, is like those of any existing form of engine, or, at all events, which is used in the same way as in any other vertical high speed engine. It is not often that an entirely new design commends itself to the critics of steam engines, and general appearance is not all in favor of Mr. Raworth's design, but the points to which exception may be taken are said to be of no importance, while great advantages and economy are obtained by the arrangement adopted. One of the engines is being run direct coupled to a Mordey-Victoria alternator, at work at the Windermere Electricity Works, England, and we omit a view in perspective. Figs. 2 and 3 show by vertical sections in the line of the shaft, and transversely to it, the whole of the arrangements of the parts. Fig. 4 shows the separate valve chest or case. Figs. 10 to 14 show the connecting rod, the main bearings, the cross-head bottom piston rod gland, the central piston rod packing, the piston ring and the eccentric rod joint.

The first points which will strike the reader, after the main one of novelty, are the simplicity of the engine, the shortness of the ports and smallness of the clearance spaces, the arrangement of the steam and receiver spaces, and of the means of cushioning. The manufacturer will also observe that the engine is nearly all lathe work. The arrangement of the cylinders and the cycle are tandem, and independent Corliss valves for the high and low pressure cylinders are used. The high pressure steam acts on the underside of the high pressure cylinder, and when the piston has approached the upper limit of its stroke, exhaust through a number of holes, as shown, into the surrounding receiver, commences. The high pressure cylinder is, it will be seen, jacketed inside and outside by steam at the pressure of the receiver. On the commencement of the down stroke of the pistons the steam in the receiver and high pressure cylinder acts on the upper part of the low pressure cylinder, very free exhaust being obtained by a circumferential ring of holes, as in the high pressure piston, and by the opening of the exhaust valve. In the section, Fig. 2, the valves are shown as closed both to exhaust and to inlet, the piston performing the up stroke. Cushioning is effected in the way ordinary in double acting engines, and water is easily got rid of. From the high pressure cylinder it descends into the low, from which it passes away freely into the lower exhaust chamber, through the ring of holes in the lower part of the cylinder. In the high pressure cylinder it collects in the annular channel shown (Fig. 2),

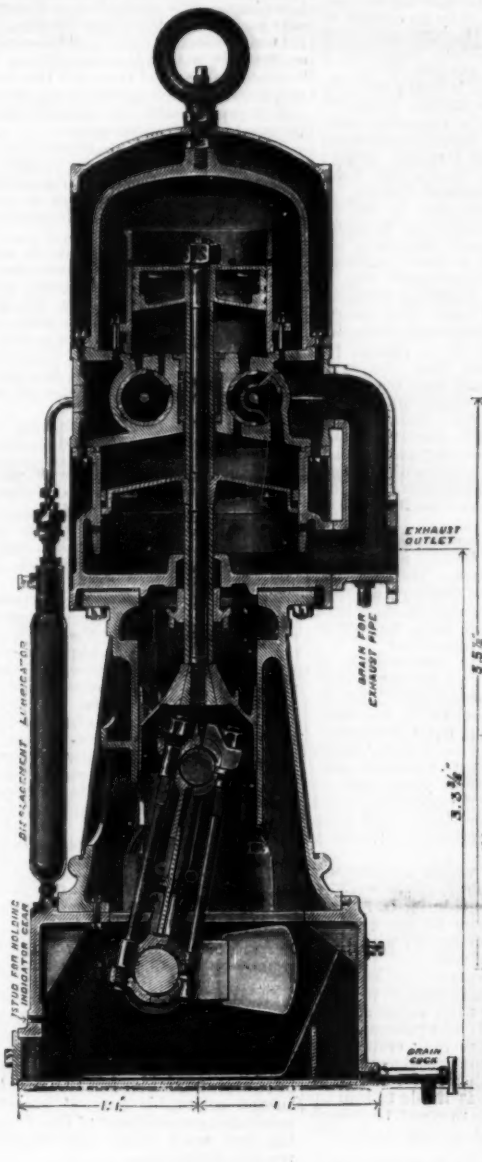


FIG. 2.—TRANSVERSE VERTICAL SECTION.

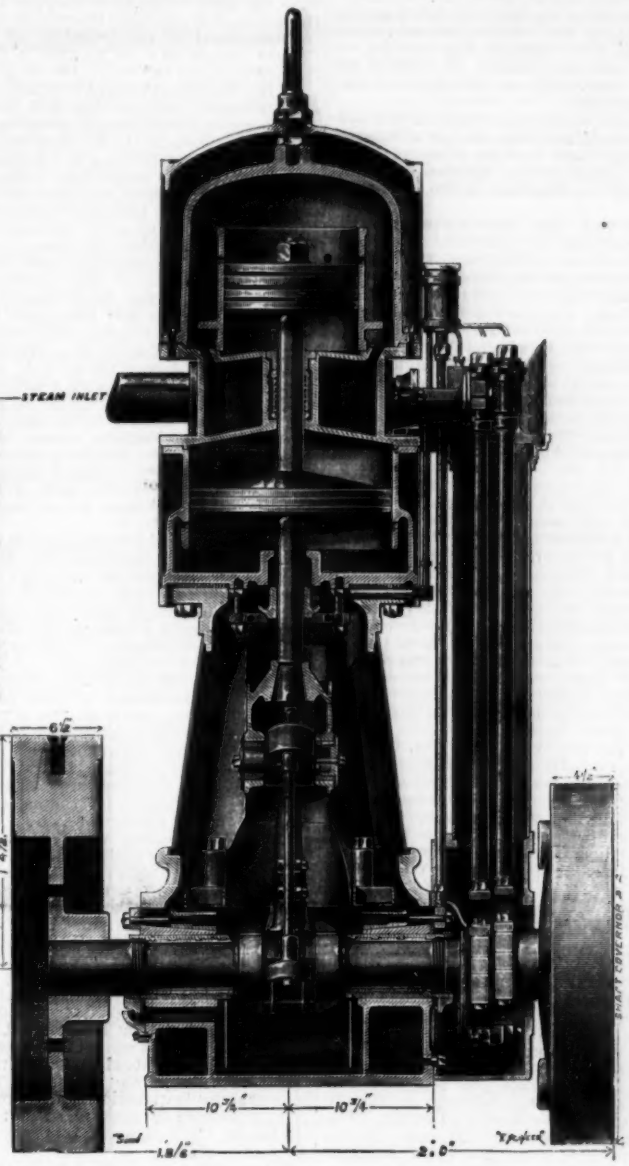
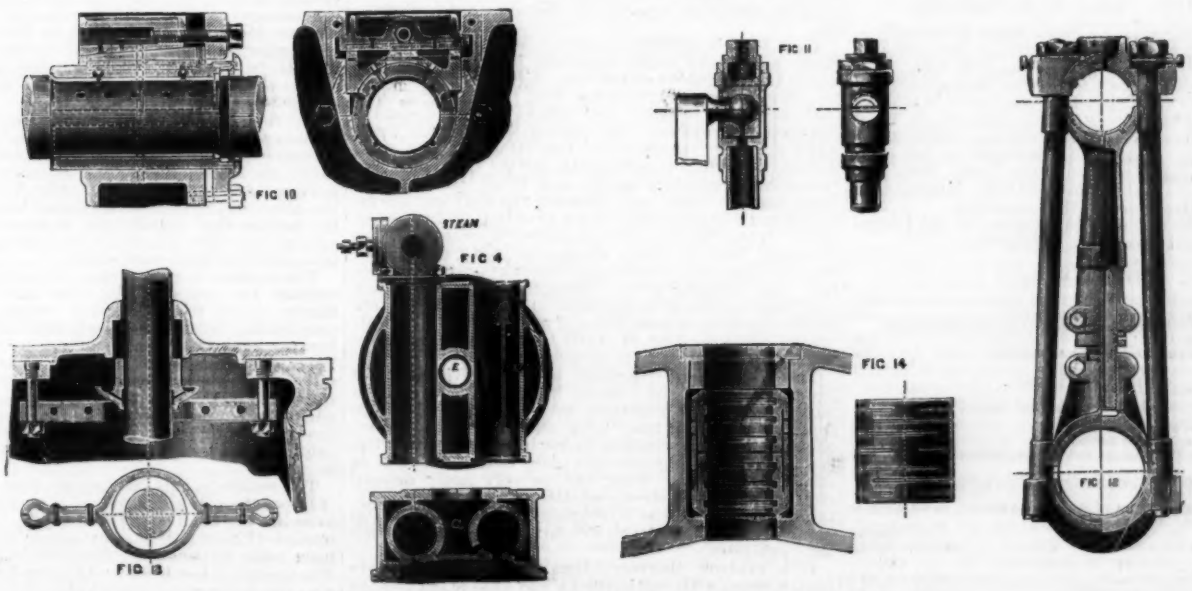


FIG. 3.—LONGITUDINAL VERTICAL SECTION.



RAWORTH'S NEW UNIVERSAL HIGH SPEED ENGINE.

from which it freely passes away through the low pressure valve by the large port shown and channels leading into it. From the receiver the water passes through two side ports into the cavities, a (Fig. 4), and thence through the valve into the low pressure cylinder. The exhaust from the low pressure cylinder, which does not pass away by the holes when the piston is at the bottom of its stroke, passes through the valve and thence by the valve casing into the external pipe, which is shown in Fig. 2 as connecting the upper and

lower exhaust chambers. The connection between the low pressure exhaust port and the exhaust pipe is through the ends of the valve, but this cannot be shown clearly in the engravings. The method of driving the valves is such that each valve can automatically take up wear like an ordinary slide valve. The high pressure valve wears upward and the low pressure downward. The function of the upper part of the low pressure valve is simply to isolate water, which may lodge in the valve cavity from the high pressure steam; its removal would not appreciably affect the steam consumption.

The ports communicating through the low pressure valve between the receiver and the low pressure cylinder are seen at a a, Fig. 4; the section (Fig. 2) being on the center line does not show them. The valves are worked by ordinary eccentrics, one of which is controlled by the shaft governor.

When triple expansion engines are made on this system the high and intermediate form one pair of tandem cylinders over one crank, and two low pressure cylinders are used over a second crank. Quadruple expansion engines are similar to a duplicate of the compound engine illustrated.

When working on full load, non-condensing, the steam consumption, taking the full load diagrams, averaged 19·8 lb., and with two-thirds load 20·1 lb. Unless, therefore, it is conceivable that this result may be lessened, it would appear that the method of jacketing the high pressure cylinder with low pressure steam is an economical one, and any loss that may accrue in the high pressure is more than compensated for by the gain on the low pressure cylinder. The figures we have given were obtained by some observers during a recent visit by a party interested in steam engine performance, arrangements being made by the Brush company for the purpose. The dimensions of the engine are: high pressure cylinder, 9·81; low pressure, 14·5; and stroke, 6 in.

The main bearings and method of setting them up are shown by Fig. 10, and the arrangement of the brasses in the end of the eccentric rods and spherical end to the valve rod arms are shown by Fig. 11. The main connecting rod is shown in Fig. 12. This rod answers well in practice. It consists of two main parts, an external frame taking the upward pull, and consisting of two rods fixed in the caps of the big and little ends, and a central strut taking the downward thrust of the low pressure piston. The central part is in two parts, connected by a large screw gripped by the split bosses with bolts and nuts to either part. With this arrangement, adjustment is so easy that it may be expected always to be done. The arrangement of the low pressure gland is shown in Fig. 13, and of the packing between the two cylinders in Fig. 14.

For obtaining an automatic graphic representation of the velocity of the crank shaft throughout a revolution, Mr. Raworth employs a very ingenious apparatus, which he has named the velograph, by means of which the exact cause and extent of irregularity in the turning of an engine can be ascertained in a few minutes, and usually a cure can be effected in the course of a few hours.

For our illustrations and the accompanying details we are indebted to the Engineer.

P. VILLARD describes, in the Comptes Rendus, a crystallized hydrate of argon with water. Argon is compressed to 150 atmospheres in the presence of water cooled to nearly zero. On chilling the tube at a small point, crystallization begins, proceeding out from the point cooled. Or crystallization may be induced by introducing a crystal of the hydrate previously formed. Crystallization does not take place, however, by merely compressing argon in the presence of cold water. The crystals are colorless and small, though easily visible with a lens. The tension of dissociation at 0° is about 105 atmospheres; at + 8° C., 210 atmospheres.

A WORD TO MAIL SUBSCRIBERS.

At the end of every year a great many subscriptions to the various SCIENTIFIC AMERICAN publications expire, and the present issue closes the year 1896.

The bills for 1897 for the SCIENTIFIC AMERICAN, the SCIENTIFIC AMERICAN SUPPLEMENT, and the BUILDING EDITION of the SCIENTIFIC AMERICAN have been mailed to those whose subscriptions come to an end with the year. Responding promptly to the invitation to renew saves removing the name from our subscription books, and secures without interruption the reception of the paper by the subscriber.

The prices of the different publications in the United States, Canada and Mexico are as follows:

RATES BY MAIL.

Scientific American (weekly), one year	$3.00
Scientific American Supplement (weekly), one year	5.00
Export Edition of the Scientific American (monthly, in Spanish and English)	3.00
Building Edition of the Scientific American (monthly)	2.50

COMBINED RATES

In the United States, Canada and Mexico.

Scientific American and Supplement	$7.00
Scientific American and Building Edition	5.00
Scientific American, the Supplement, and Building Edition	9.00

TERMS TO FOREIGN COUNTRIES.

The yearly subscription prices of Scientific American publications to foreign countries are as follows:

	U. S. Money.	English Money, £ s. d.
Scientific American (weekly)	$4.00	0 16 5
Scientific American Supplement (weekly)	6.00	1 4 8
Building Edition of the Scientific American (monthly)	3.00	0 12 4
Export Edition of the Scientific American (monthly) in Spanish and English	3.00	0 12 4

COMBINED RATES TO FOREIGN COUNTRIES.

Scientific American and Supplement	$8.50	1 14 11
Scientific American and Building Edition	6.50	1 6 9
Scientific American, Scientific American Supplement, and Building Edition	11.00	2 5 2

☞ Proportionate Rates for Six Months.

The above rates include postage, which we pay. Remit by check, postal or express money order, or draft to order of MUNN & Co., 361 Broadway, New York.

NOTES ON THE HYDROMETALLURGY OF GOLD AND SILVER.

By W. GEORGE WARING.

THE wet methods for extracting gold and silver have gradually attained an importance that is undeniable, though exaggerated by political writers, who, through ignorance of the real facts of mining and metallurgy, fear an excessive production of these metals. The actual advances of the present day do not consist in the discovery of new processes, promising to extract more than the assay value, or to cheapen the cost to less than the expense of crushing the ore; but they do consist of improvements in manipulation of the old and well founded methods so as to gain a certain economy, if it be only of the value of a few cents per ton of ore.

As the limit of economical extraction is thus gradually approximated, however, the field for further improvements grows wider, deeper research is required, more minute problems are to be attacked, and the success of establishments employing the highest business ability and technical skill encourages other works that have hitherto been satisfied with less economical results.

I have in mind a particular plant situated in one of the most prosperous silver mining regions in Mexico,* which plant has grown up from a small beginning ten years ago as a custom mill, until it is now reducing about 100 tons daily of ores, mostly purchased, and in competition with the large central smelting works at Monterey, El Paso and San Luis Potosi. The freight rates being merely nominal, this leaching establishment is profitably handling all ores offered, at a charge for treatment not exceeding $8 gold per ton. Yet this same enterprise started with a mill that had been previously a complete failure, and in a camp filled with wrecks of other failures in the same line; among them several extensive leaching plants, with Stetefeldt and mechanical furnaces, besides a number of "patent process" establishments. Of that earlier era nothing survived except one or two large amalgamation patios, and a few small smelters, which lingered until a year or so ago.

A recent chemical investigation at these works, having for its object to determine the influence of minute traces of rare elements in the ores upon the roasting and leaching processes, served to emphasize the idea of my first paragraph, and at the same time to show how little is generally known about some facts in hydrometallurgy that ought to be better understood.

The so-called "going back" of the chlorination of chloridized ores is one of these facts. A proper understanding of the causes of this phenomenon throws much light upon many of the mysteries of leaching, and helps to explain many perplexing little irregularities that so often occur, as well as to remedy them most effectually. Some of the most valuable contributions to hydrometallurgy of recent years, such as the Russell process, and the use of hypochlorites and cyanides in gold extraction, would doubtless find more extended application were the chemistry of leaching roasted ores better understood.

Consider the complex conditions which accompany the preliminary preparation of a simple silver ore for leaching with "hypo." An ore containing only such common elements as silica, lime, iron or manganese, lead, zinc, sulphur and perhaps antimony, which has been roasted with say 10 per cent. of salt.

When charged into the leaching vats it may be quite warm or even hot. It may contain from 2 to 8 per cent. of undecomposed NaCl, along with other soluble chlorides such as $CaCl_2$, also $MnCl_2$, anhydrous ferric salts (rarely ferrous salts, though such may result during leaching by mutual decomposition); undecomposed ZnS. Sb_2S_3, etc., may be present in small amount, or in considerable quantity if the ore is liable to ball up or agglomerate in roasting so as to prevent thorough oxidation, CaO may also be present, as well as various sulphates, etc.

When water is admitted into a vat full of chloridized ore, the alkaline chlorides begin at once to dissolve, making a brine which increases in density and temperature as it passes through the ore, and at the same time increases in capacity to dissolve AgCl, $PbSO_4$, etc.

That AgCl in solution is readily decomposed by ZnS, Sb_2S_3 and many other sulphides is well known; and under the conditions stated some AgCl must inevitably be precipitated as AgS, and so lost. Reducing agents, such as $FeSO_4$, Na_2SO_3 and others that reduce silver sulphate, fluoride, etc., are quite without action upon AgCl in briny solution—a fact that is not well known, but minor reactions can and do take place between some reducing agents and ferric and perhaps other metallic salts, and between the CaO and the reduced metallic salts that cause eventual reduction of AgCl. Thus ferrous or manganous hydrate may be produced, both of which decompose AgCl, the former very energetically, resulting in ferric hydrate and chloride, and metallic silver. Manganous hydrate, which is of very common occurrence in leaching, acts more slowly, an hour or even more of contact with a hot saturated saline solution of AgCl being required to completely precipitate all the silver as Ag.

These important reactions are very evidently not generally known, and I doubt if they have ever been mentioned in the literature of metallurgy, although frequent references have been made to the injurious effects of alkaline solutions in leaching. Of course, the last named reactions can take place only in neutral or alkaline solutions. They can be very easily demonstrated by heating strong solution of common salt containing AgCl with the hydroxides named. The action of mineral sulphides, even in coarse grains, can be similarly exhibited.

It is evident, therefore, that a silver ore may have been roasted with salt in such a way that 95 per cent. or more of the silver may have been converted into AgCl, and yet yield only 80 per cent., or even as low as 30 per cent. to treatment with hypo. The laboratory chlorination test therefore may fail to exhibit the actual degree of chlorination obtained. This may be demonstrated in particular instances by digesting the assay sample with a considerable amount of water (so as to avoid the production of a brine capable of dissolving traces of the AgCl) with a very little of some ferric salt, so as to neutralize the CaO, and filtering off the solution before treating with hypo. The aqueous solution may be neutral, or it may be slightly acidulated, and hot, and contain a little free chlorine, as will be the case if the ferric salt has been prepared with copperas and calcium hypochlorite. The results will frequently, and especially upon calcareous ores, considerably exceed the highest extraction possible with hypo or cupreous hyposulphite, thus showing that some of the advantages attributed to the action of the latter salt may be due to reactions quite different from those claimed for it.

* The Hidalgo Works, of Minas Nuevas, near Parral, Chih.

My attention was first called to the injurious reactions caused by the presence of alkali in wash water leaching in 1886, when it was discovered quite accidentally at Lake Valley, New Mexico, during a test of the Russell process, that a preliminary washing of the roasted ore with water containing copper sulphate gave better final results than did the use of cupreous hyposulphite in the hypo leaching, and I believe that such use of copper salts was incorporated in Mr. Russell's additional patent applications.

In the same year, at Silver City, with a similar ore, I observed that ferric salts yielded similar results. The ores carried considerable manganese and lime, and the increased extraction was due to simple neutralization of alkali, preventing the formation of manganous hydrate.

Ferric sulphate or chloride is more efficacious than cupric sulphate in such a case, because the latter salt often contains ferrous sulphate, giving rise to the very dangerous ferrous hydrate, the most deleterious substance that has been met with, to my knowledge, in silver leaching, next to some raw minerals unoxidized by roasting. Fortunately, however, the finely divided precipitated metallic silver can be rechloridized readily in the ore by a weak solution of clear hypochlorite of lime.

The sulphide of silver thrown down in the wash water leaching does not yield so readily. It is here that the Russell process offers a partial remedy. But it seems to be only partial. Is part of the sulphide converted into an insoluble allotropic modification, that it fails to dissolve completely, or is its composition changed into an insoluble sulpho salt? The most perfect remedy yet discovered for injurious sulphide reactions is to perfect the roasting, to which I shall refer futher on.

The use of ferric salts in neutralizing wash water has the advantage of not introducing copper into the sulphides, and thus making them difficult to refine. Where the use of cupreous hyposulphite is necessary in the final leaching, I imagine that much of the difficulty arising from the presence of so much copper in the sulphide product might be obviated by a judicious employment of ferric chloride in connection with the cupreous salt. The solution is easily made from copperas by adding to it the requisite amount of sulphuric acid and then running in clear bleaching powder solution to slight excess. It can only be successfully applied by sprinkling on the cooling floor before the ore is charged into the vats. If applied upon the surface of the ore in the vats, the advancing portions of the fluid will have been deprived of the salt before it is sufficiently saline to take up much Ag.Cl.

The procedure will vary, of course, with circumstances. In one instance in which this method had only about two months' trial in New Mexico, having been interrupted by the rapid fall in the price of silver, remarkable economical results were obtained by using the strongly saline wash water repeatedly, after precipitation and oxidation,* to wet down the roasted ore upon the cooling floor. The completely saturated portions were led into evaporating basins to recover the salts, which were considered to be more effective for chloridizing purposes than ordinary NaCl, on account of containing much Na_2SO_4 and $ZnSO_4$. The ores contained a notable amount of gold, all of which, with much the greater part of the silver, was recovered from the first wash water, the remaining silver being extracted with hypo.

The refining of wash water sulphides often presents difficulties on account of the presence of an excess of copper. This embarrassment has been overcome in various ways. One case in particular is interesting, not because of any particular trouble in refining, but because of the collateral object in view, which was to economize the hypo, expensive because of the remote locality, in the Sierra Madre of Sonora. The ore contained about 0·5 per cent. only of copper. I recommended the following plan:

The first outflow of wash water, containing all the soluble copper and all the silver dissolved by the brine, is conducted into a special tank, about half filling it. When the hypo solution first appears, the first dilute portions are also conducted into the same tank, also the dilute tail hypo from a finished leaching vat, that is, the portion that usually goes to waste after the main part of the stock solution in the tailings has been displaced by the final wash water.

The amount is regulated so as not to completely precipitate the copper. The silver and copper are thus thrown down from the wash water as insoluble hyposulphites, and the precipitate after draining is thrown upon the surface of an ore vat, in which the hypo leaching is nearly finished. Additional hypo dissolves the silver and copper, the former going through the ore to be precipitated with the regular sulphides, while the copper is reprecipitated upon the surface of the ore as sulphide by the action of the finely divided sulphides that usually coat the surface during the hypo leaching.

The results in this instance are that there is no waste of hypo, the sulphide product is extremely pure, never assaying less than 60 per cent. silver, and consequently refined without roasting, by simple fusion upon a lead base, with just enough litharge to oxidize the sulphur. The operation is extremely simple and easy. Incidentally also the tailings are remarkably clean, in fact it would seem that the essential reaction of the Russell process may occur, although procedure is quite different, and the object sought being quite the reverse of that actually obtained in the Russell procedure, namely, the production of pure sulphides free from copper.

With regard to roasting furnaces, I have already mentioned the necessity for perfect roasting, and to obtain this the furnace must be adapted to the ore. There is no ore that cannot be successfully roasted or chlorid-

* In this case the copper was thrown down by scrap iron, and the solution oxidized by bleaching powder solution.

ized in one or another of the several types of furnace in use, that is, the gravity type, the revolving cylindrical type, the hand or mechanical reverberatories, or the muffle type.

But the solution of the important question of what type to use should in every case be made by a thoroughly experienced metallurgist, instead of being left, as is usually the case, to be settled by the simple advice of an advocate of some particular style of furnace. The arguments generally adduced to prove the advantages of certain mechanical conditions peculiar to any furnace cut no figure whatever in comparison with the importance of the chemical conditions required in the roasted ore. No one who does not understand the nature and importance of these conditions, and how they are produced, is competent to advise in so important a matter.

It would seem almost superfluous to write so insistently upon this subject, in view of the many standing monuments of folly to be seen in every large mining district in the shape of furnaces of almost every type that have failed to accomplish what they were built for. They speak volumes more than I could write. Readers of the Engineering and Mining Journal are familiar with instances that have been cited in its pages of vast losses and expenditures and experiments with the right kind of furnaces in the wrong places.

Ores balling up in revolving furnaces and inclosing undecomposed sulphide of zinc, etc., in fusible CaCl or CaF, leady ores matting in gravity furnaces, and in other types undesirable chemical combinations being produced like oxychloride of zinc, which sets or cements the roasted ore into solid rock the minute water touches it, are familiar examples, yet none of these or any other horrible disasters need occur if the proper method of roasting be adopted.

Muffle furnaces, of proper construction, using the regenerative principle, are admirably adapted to use in many cases where ores containing gold and silver along with copper or zinc; and perhaps other metals, are to be leached for the extraction of both gold and silver and one or more of the other metals after a single roasting. I only refer specially to the muffle type because it is so little known in this country and because an erroneous idea as to the fuel economy of this type has been current in metallurgical literature. The muffle furnace cannot take the place of the revolving cylinder for many purposes, and it lacks as yet one very desirable feature, a mechanical finishing hearth, or, at least, some system of mechanical rabbling, to make it very generally useful. But it is a mistaken notion that the regenerative muffle furnace is more expensive to fire than other furnaces. My experience has been quite the reverse. Such a furnace built at Silver City, New Mexico, with a hearth area of 16 × 40 ft., roasted from 12 to 25 tons daily in 1879 of ores and concentrates containing 10 to 30 per cent. sulphur, the hearth being almost uniformly at about 500° C., while the escaping products of combustion rarely reached above the temperature of boiling water. The volatile products from the muffle hearth were condensed in coke towers, after passing through a long flue, and the acid liquors used to leach out copper, etc., from the roasted ore.

A matter of importance connected with roasting is the degree of resistance afforded by various sized quartzose particles to the disintegrating influences at work in the roasting process. This question has an important bearing upon volatilization, as the following test will show:

A silver ore in Northern Sonora—antimonial sulphide, free from copper, in quartz gangue—when reduced to the size usually called "16 mesh," and roasted with 10 per cent. of salt, showed no considerable loss by volatilization, the leaching extraction being 96·4 per cent., and 3·4 per cent. remaining in the tailings. When reduced to 30 mesh size, however, with the same treatment the volatilization loss was 11 per cent., the extraction being 86·3 per cent., with 2·7 per cent. left in the tailings. [At 45 mesh the volatilization loss had increased to 42 per cent., the amount remaining in the tailings being constant at 2·7 per cent.

The limit of resistance to disintegration should be ascertained by experimental roasting and treatment with strong acids and other solvents, and then the furnace work should be brought up to the highest percentage that can be extracted by such tests, instead of allowing poor furnace work to set the limit of efficiency in gold and silver extraction, or to determine the crushing size of the ore.

Much is yet to be learned about roasting methods, through analyses of furnace fumes and gases, and the time has come when leaching and chlorination works should find out what is going out in smoke. The importance of such investigations was long ago recognized in the iron industry, and they are of relatively greater importance in the metallurgy of the precious metals, as Eggleston and others have suggested.—Engineering and Mining Journal.

OYSTER CULTURE IN RELATION TO DISEASE.

By T. E. THORPE, in Nature.

UNDER the above title the medical officer of the local government board has just issued a supplement to his report for 1894-95 dealing with reports and papers on the cultivation and storage of oysters and certain other edible mollusks in relation to the occurrence of disease in man. An inquiry on this subject was bound to be instituted sooner or later. There has been an uneasy feeling for many years past that the infection of enteric or typhoid fever is at times due to the consumption of uncooked oysters; and in his report on cholera in England, in 1893, Dr. Thorne Thorne expressed his conviction that the distribution of shell fish from Cleethorpes and Grimsby, as a center, had been concerned in the diffusion of scattered cases of cholera over a somewhat wide area of England, owing to the fact that oysters and other mollusks at these ports were so deposited and stored as to be almost necessarily bathed each tide with the effluent of sewers at that time receiving cholera discharges. In the early part of 1895 Sir William Broadbent also publicly announced his conviction that oysters were occasionally capable of transmitting the infection of typhoid fever, and the fact received startling confirmation from a report to the State Board of Health of Connecticut, U. S. A., by Prof. Conn, on an oyster epidemic of typhoid at Wesleyan University, Middletown, Conn., in which some twenty-six cases of that disease were indisputably traced to the consumption of raw oysters which had the opportunity of becoming specifically contaminated by sewage delivering at the time the discharges of typhoid patients. A similar outbreak of Saint-André de Sangoins, in the Mediterranean department of Herault, was investigated by Dr. Chantemesse, and traced to oysters received from Cette, on the coast of the same department, where, according to a commission subsequently appointed, the oysters had been stored in waters highly contaminated with sewage.

Under these circumstances, the local government board determined to institute a searching inquiry into the conditions of oyster cultivation and storage along the coasts of England and Wales, and to cause bacteriological investigations to be made as to the power of the oyster to absorb, retain and transmit the typhoid bacillus and the cholera vibrio. The first part of the inquiry was intrusted to Dr. Timbrell Bulstrode and the second portion to Dr. Klein. Their reports, which are suitably illustrated with photographs and maps, constitute the material on which Dr. Thorne Thorne bases his introductory remarks. In the appendix are given a copy of Prof. Conn's report already alluded to, and an extract from the Proceedings of the Académie de Médicine, in Paris, relating to the spread of disease through the agency of oysters.

The value and extent of the oyster trade in this country may be gleaned from the following figures, furnished by Dr. Bulstrode. In 1894 there were landed on the English and Welsh coasts by English dredgers 27,747,000 oysters, valued at £84,271, the average price being per 100, 6s. 1d., and per 1,000, £3 0s. 10d. These were delivered on the several coasts as follows:

	Oysters.	Value.
East coast	16,833,000	£58,300
South coast	4,251,000	11,186
West coast	6,663,000	14,785
	27,747,000	£84,271

These figures relate only to oysters landed by English boats employed in the home industry; in addition enormous quantities are imported from abroad, partly for relaying and partly for more or less immediate consumption. American oysters, known as "Blue Points," "East Rivers" and "Sounds," are mainly received at Liverpool and Southampton, while the Dutch and Belgian oysters chiefly come to Grimsby and Brightlingsea. A considerable number also are received from Scotch and Irish beds.

It is generally assumed, at all events, by the more educated lovers of the bivalve, that oysters are "out of season" during such months as have not the letter "r" in their names, and, as a matter of fact, the "close time" for oysters born and bred in this country extends from May 14 to August 4, that is, during the spatting season. But that portion of the community which is referred to in the report as "the less fastidious class," and which is "addicted to the practice of seaside trips of brief duration," is addicted also to the practice of eating the oyster at any time of the year it can be got, and in the summer months, therefore, has to content itself with the imported varieties, the restriction as to "close time" not applying to oysters taken in the waters of a foreign state.

It would appear from the returns that the largest number of oysters is consumed in September; but, although the number eaten diminishes as the year draws to a close, their value steadily increases up to December, when it gradually diminishes month after month, until it reaches a minimum in June or July.

As the result of Dr. Bulstrode's inquiries and observations, it is distinctly disquieting to be told that only a few of the oyster layings, fattening beds, or storage ponds round the English and Welsh coasts can be regarded as theoretically free from every possible chance of sewage pollution. At the same time, in the case of the majority of them, the polluting matter is mixed with so vast a bulk of water that there is little substantial risk of deleterious influence. The possible mischief is due to the circumstance that the cultivation of the oyster is mainly carried on at points on the coast which are readily accessible, and where labor can be easily obtained, or, in other words, in tidal estuaries in the neighborhood of more or less populous places, into which, therefore, the sewage of such places is apt to be delivered. In the report, three such localities are singled out for special condemnation; viz., Southend, where, as regards one laying, "the sea bottom and the matters floating on the surface afford the most obvious proof that the conditions are filthy in the extreme;" at Cleethorpes, where the layings are exposed to the influence of sewer outfalls, serving (counting that of Grimsby) populations of about 67,000; and the Medina, in the Isle of Wight, of which it is stated that "it seems almost beyond comprehension how any one could venture to 'fatten' oysters for human consumption in a river estuary such as this, which is fouled above the layings by the crude sewage of Newport, with its 10,000 inhabitants, by the effluent from the neighboring prison and barracks, and by the overflow from the workhouse cesspool; and which receives into it immediately below the layings the contents of eight other sewer and drain outfalls from East Cowes and West Cowes." It is further pointed out that "the layings in the Penryn River, Cornwall, and those in Brightlingsea Creek, in Essex, also call for especial notice in connection with the obvious risk of sewage pollution. At Brightlingsea this risk has more than once been drawn attention to by the local health officer. The layings in the South Channel, off Southwick, near Shoreham, are similarly exposed to sewage; and in a minor degree, on account of the great bulk of water there in question, such layings as those in the Menai Straits come under suspicion. From most, if not all, of these layings, oysters are dispatched direct to market."

On the other hand, some of the most celebrated layings on the coast of Essex and Kent—as in the Crouch, Roach and Blackwater, and off the Swale—are practically free from risk, although the layings in the bed of the Colne which presumably furnish the supplies for the time-honored "Colchester feast," are subjected to the comparatively concentrated effluent of Colchester sewage at low water, and to the additional pollution to which the river is subjected at Wivenhoe and Rowhedge.

The conditions under which the oysters are stored in beds, ponds, or pits, pending dispatch to market, naturally received close attention. The layings or "fattening" places might be everything that could be desired, but the oysters, when lifted, might still be stored in a most objectionable manner. The boxes off Southend Pier, for example, float in what is practically dilute sewage. A set of storage pits at the mouth of the Blackwater was found to be within forty-three yards of the point at which the drainage of twenty houses is discharged. At Wivenhoe "it is impossible to see how the oysters there, stored in pits, can escape contamination by sewage." The means for the storage of oysters in the Fish Dock at Grimsby are stated to be particularly offensive and dangerous. "It would be difficult to find much worse conditions than those under which certain storage pits are placed at Poole." . . . "At Warsash, above the junction of the Hamble River with Southampton Water, a sewer was found opening out just between two oyster ponds. Again at Emsworth, near Havant, a sewer and certain drain outfalls have been conveyed into the middle of a group of oyster pits, and matters are little better at Bosham."

On the other hand, the methods of storage on the Crouch and Roach, and for the most part also of the Blackwater, leave little to be desired, and the same may be said of the layings and means of storage in the Helford River, in Cornwall, and at Newtown Estuary, in the Isle of Wight.

To judge, however, from the frequency of instances to the contrary, it would almost seem that the cultivators were under the belief that the oyster actually enjoys himself and waxes fat in insanitary surroundings. Precisely the opposite is the case. No one enjoys the confidence of the oyster to a greater extent than Prof. Herdman, or is better able to appreciate his innermost sentiments; and we gather from Prof. Herdman's recent work that the oyster—especially the British born and bred oyster—is, in reality, a cleanly, self-respecting mollusk, with an appetite not less dainty or fastidious than that of the epicure for whose gustatory pleasure he is supposed to live. Indeed, if oysters in general had only the locomotive powers of their brethren in the classical legend of the Walrus and the Carpenter, there is very little doubt that, in many cases, they would quickly move off in search of quarters more salubrious than those in which they are often compelled to exist.

It is not easy to indicate how the present condition of things may best be remedied. Oysters, of course, are not a necessity, unless to the hardly driven brain worker, to persons of feeble digestion, or to convalescents. Unless something is done, therefore, to reassure the public mind—either by the collective action of the oyster breeders themselves, or by systematic inspection on the part of the state—the future of the industry will be seriously jeopardized. As it is, the "scare" has done very great damage to the trade, and the good and the bad alike have indiscriminately suffered. To the statesman who is concerned with the welfare of a littoral population from which the personnel of our navy and coast defenses is largely recruited, the problem has even a wider and deeper significance. On every ground, therefore, the question calls for prompt remedial action.

At the conclusion of his report Dr. Bulstrode makes some reference to "green bearded" or "green finned" oysters. These oysters find but little favor in this country, although, as is well known, they are much appreciated in France, and the "huîtres vertes" or "huîtres de Marennes" obtain a far higher price in the Paris market than the "huîtres blanches." This green color, which is met with to a small extent in certain Essex oysters, has been the subject of repeated investigation during the last seventy years, notably by Gaillon (1820), Valenciennes (1841), and Puségur and Decaisne (1877). The last named observers found that the green tint was due to the inclusion of a diatom, Navicula ostrearia, or, as it is now called, N. fusiformis, taken up from the "claires" in which the oysters are confined. These observations were confirmed and extended, in 1885, by Prof. Ray Lankester, who showed that a blue pigment, which he termed "marennin" occurs in the Navicula, and is either "uniformly diffused throughout the cell protoplasm," or "confined to the ends of the elongated cell body" (Bulstrode). In the oyster the green coloring matter is localized on the surface of the gills and labial palps in "certain peculiar cells of the superficial epithelium." It is the deposition of this blue pigment (marennin) in the yellowish brown gills which, according to Prof. Lankester, gives rise to the green appearance of the "huîtres de Marennes."

It has been often alleged that this greenness is due to copper, and as a matter of fact copper has frequently been detected in oysters since Bizio, in 1835, first discovered it in the organic substance of the mollusk. Dr. Bulstrode, from time to time, sent the writer of this notice oysters from different localities, and copper was uniformly found in them, although in the Marennes oysters it was present in minute amount only—far less, indeed, than in certain oysters of a normal color. But there is no question that the greenness of certain oysters, especially of those found in Falmouth and Truro waters, is due to copper. The color, both in character and distribution, is, however, quite different from that of the Marennes oyster. The green Cornish oyster is unsalable in this country—at least for immediate consumption—as it leaves a distinct metallic taste in the mouth, similar, it is said, to that due to "sucking a penny." Dr. Bulstrode caused a number of such oysters to be sent to me at different times. On incineration under conditions which precluded the possibility of the introduction of copper, there was no difficulty in detecting the presence of that metal in the ash. Indeed, here and there in the ash were particles of Alexandrine or Egyptian blue, which, as Davy found long ago, is a frit, made by heating together soda, lime, sand and copper. The amount of copper, on the average, was not more than about 0·02 grain per oyster, but as it is obviously caused by the mechanical retention of cupriferous particles, individual oysters might, and indeed did, contain large quantities. On examining the mud of the locality in which such green oysters occur, it was found to contain 0·148 per cent. of copper. On relaying, the green Cornish oyster gradually loses its color and also its metallic taste; specimens of such relaid oysters were found to contain only

0·0060 grain of copper per oyster, which is practically the same (viz., 0·062 grain) as that found in Whitstable oysters which had never been green. This amount would seem, therefore, to be normal to the oyster, and to be probably due to the presence of hæmocyanin, first found by Fredericq in the blood of the octopus, and since shown to be present also in many mollusca.

THE LONGLEAF PINE AND THE NAVAL STORE INDUSTRY.*

By CHARLES MOHR, Ph.D.

THE NAVAL STORE INDUSTRY.

THE resinous product of the longleaf pine furnishes the raw material for the production of naval stores, one of the most important industries in connection with the resources of the American forests. At present the bulk of these stores used in the world is derived from the forests of longleaf pine, and hence this industry is almost entirely confined to the coast pine belt of the Southern States, the proportion contributed by France, Austria, and other countries being insignificant.

For the year 1892 the foreign export of spirits of turpentine alone amounted to over 260,000 casks and the total production exceeded 350,000 casks. To produce this amount of spirits at least 2,500,000 acres must have been in orchard, and since over one-third of the total production is furnished by orchards being worked for the first year, over 800,000 acres of virgin forest must be attacked annually to supply present demands.

Under the name of naval stores are comprised the products derived directly or indirectly from the resinous exudation of conebearing trees, mostly pines, including tar, the product of the destructive distillation of the wood of pines highly charged with resinous matter. The name is undoubtedly derived from their extensive consumption in the shipyards and on board of vessels. The products are:

RESIN, OR CRUDE TURPENTINE.

The resin of the longleaf pine recently exuded is almost colorless, or of a pale straw color, of the consistency of honey, having a terebinthinous odor and taste, and like all substances of the same class, is insoluble in water, but soluble in alcohol, ether, and spirits of turpentine. It consists of a volatile oil and a solid resin held in solution partially suspended in the former. The best quality is obtained during the first year the tree is worked, known as "virgin dip" or "soft white gum," which is almost colorless and contains the largest quantity of volatile oil. In the following year it is of a deeper yellowish color, the "yellow dip," which with each succeeding year becomes darker in color, more viscid, and poorer in volatile oil.*

The resin toward the close of the season produced on the tree under the influence of a cooler temperature is called hard gum, or scrape. This solidified resin of whitish to yellowish color contains only half of the quantity of the spirits of turpentine obtained from the dip or soft gum. By the distillation of the crude turpentine the naval stores of most importance to trade are obtained.

SPIRITS OF TURPENTINE OR OIL OF TURPENTINE.

Spirits of turpentine, or oil of turpentine, is the volatile constituent of the resin. This liquid when freshly prepared is colorless, of a peculiar odor and taste, of a density varying between 0·85 and 0·87, volatile at ordinary temperatures, boiling between 304° and 320° F. It turns polarized light to the right, a characteristic feature of the American spirits of turpentine, most of the spirits from other sources polarizing the light to the left. In its pure state this volatile oil is free from oxygen, being a hydrocarbon of the composition of $C_{10}H_{16}$. It is highly inflammable and burns with a sooty flame. It is a good solvent for many resins, wax, fats, caoutchouc, sulphur, and phosphorus, and is used in the arts and industries for the preparation of varnishes, in paints, the rubber industry, etc. Before the introduction of kerosene oil it was used extensively for an illuminator; it is also used in medicine internally and externally and often as an adulterant of various essential oils.

ROSIN, OR COLOPHONY.

The solid constituent of the crude turpentine which forms the residue remaining after its distillation. It is of different degrees of heaviness, according to the quantities of volatile oil retained after distillation, is brittle, easily powdered, of a glassy luster, and of the specific gravity of 1·07, almost without taste, of a faint terebinthinous odor. It becomes soft at about 176° F., melts between 194° and 212° F., and is soluble in the same solvents as crude resin. According to the nature of the crude turpentine, depending upon the number of seasons the trees have been worked, it shows different properties in regard to the transmission of light, and in color. It is either perfectly transparent, translucent, or almost opaque and almost colorless, or a pale straw color to golden yellow, reddish yellow, through all shades to dark brown and almost black. The market value of this article is entirely regulated by these properties. In the American market the following grades are distinguished: WW (water white) and WG (window glass), the lightest and highest priced grades, obtained from the "virgin dip;" N (extra pale), M (pale), K (low pale), I (good No. 1), H (No. 1), F (good No. 2), E (No. 2), D (good strain), C (strain), B (common strain), and A (black).

PINE TAR.

This is not exactly a by-product of the turpentine orchard, but is produced by the destructive distillation of the wood itself. It is chiefly produced in North Carolina, where this industry has been carried on since the earliest colonial times. Small quantities are produced in other sections of the Southern pine belt, mostly for home consumption. Perfectly dry wood of the longleaf pine, dead limbs and trunks seasoned on the stump, from which the sapwood has rotted, are cut in suitable billets, piled into a conical stack, in a circular pit lined with clay, the center communicating by a depressed channel with a receptacle—a hole in the ground—at a distance of 3 to 4 feet from the pile. The pile is covered with sod and earth, and otherwise treated and managed like a charcoal pit, being fired from apertures at the base, giving only enough draught to maintain slow smouldering combustion. After the ninth day the tar begins to flow and continues for several weeks. It is dipped from the pit into barrels of 320 pounds, the standard weight. One cord of dry "fat" or "lightwood" furnishes from 40 to 50 gallons of tar. The price of pine tar is quoted as low as $1.05 a barrel. Since considerable quantities of tar are produced incidentally in the destructive distillation of wood in iron retorts for charcoal and other products, the price has been greatly depressed.

COMMON PITCH.

The best quality is obtained by boiling down tar until it has lost about one-third or more of its weight. The naval pitch of commerce has more or less resin of the lowest grade added to it. Pitch is also obtained as the residue remaining from the dry distillation of rosin for rosin oil.

TURPENTINE ORCHARDING IN THE FORESTS OF LONGLEAF PINE.

In the establishment of a turpentine orchard and a still, two points must be considered, namely, proper facilities of transportation to shipping points and a sufficient supply of water for the condenser connected with the still. The copper stills generally in use have a capacity of about 800 gallons, or a charge of 20 to 25 barrels of crude turpentine. For such a still to be charged twice in twenty-four hours during the working season, 4,000 acres of pine land of a good average stand of timber are required. This area is divided into twenty parcels each of 10,000 boxes, as the receptacles are called, which are cut into the tree to receive the exuding resin. Such a parcel is termed a crop, constituting the allotment to one laborer for the task of chipping. The work in a turpentine orchard is started in the earlier part of

FIG. 1.—CHIPPING THE LONGLEAF PINE.

FIG. 2.—DIPPING THE CRUDE RESIN.

TURPENTINE ORCHARDING IN LOUISIANA.

* From the Timber Pines of the Southern United States, Bulletin No. 13, Division of Forestry, United States Department of Agriculture, Washington, 1896.

* It is still an open question whether this deterioration is necessary or only owing to faulty manipulation. Experiments to settle this question are now in progress in the Forestry Division.

the winter with the cutting of the boxes. Until some years past no trees were boxed of a diameter less than 14 inches; of late, however, saplings under 10 inches in diameter are boxed. Trees of full growth, according to their circumference, receive from two to four boxes, so that the 10,000 boxes are distributed among 4,000 to 5,000 trees on an area of 200 acres.

The boxes are cut (see engraving) from 8 to 12 inches above the base of the tree, 7 inches deep and slanting from the outside to the interior, with an angle of about 35°. In the adult trees they are 14 inches in greatest diameter and 4 inches in greatest width, of a capacity of about 3 pints. The cut above this reservoir forms a gash of the same depth and about 7 inches of greatest height. In the meantime the ground is laid bare around the tree for a distance of 2½ to 3 feet, and all combustible material loose on the ground is raked in heaps to be burned, in order to protect the trees against

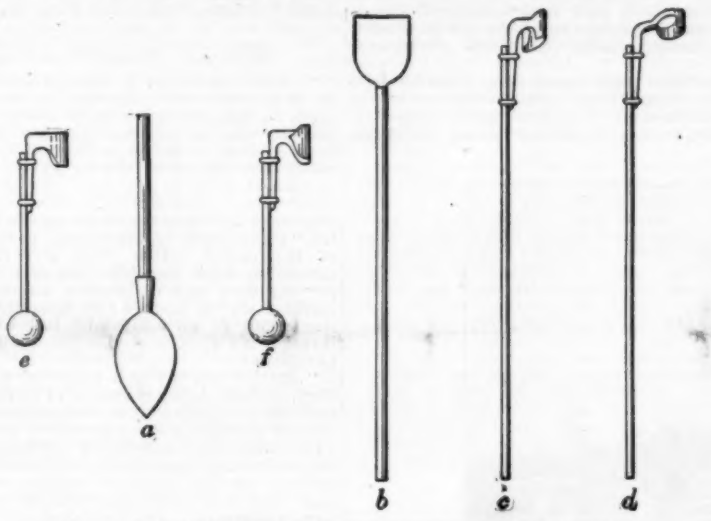


FIG. 3.—TOOLS USED IN TURPENTINE ORCHARDING.

a, dipper; b, pusher; c. open puller; d, closed puller; e, f, hacker (front and rear views).

danger of catching fire during the conflagrations which are frequently started in the pine forests by design or carelessness. The employment of fire for the protection of the turpentine orchard against the same destructive agency necessarily involves the total destruction of the smaller tree growth, and if left to spread without control beyond the proper limit, often carries ruin to the adjoining forests.

During the first days of spring the turpentine begins to flow and chipping is begun, as the work of scarification is termed, by which the surface of the tree above the box is laid bare beyond the youngest layers of the wood to a depth of about an inch from the outside of the bark. The removal of the bark and of the outermost layers of the wood—the "chipping" or "hacking"—is done with a peculiar tool, the "hacker" (Fig. 3, e, f), a strong knife with a curved edge, fastened to the end of a handle bearing on its lower end an iron ball about four pounds in weight, to give increased force to the stroke inflicted on the tree, and thus to lighten the labor of chipping. As soon as the scarified surface ceases to discharge turpentine freely, fresh incisions are made with the hacker. The chipping is repeated every week from March to October or November, extending generally over thirty-two weeks, and the height of the chip is increased about 1½ to 2 inches every month. The resin accumulated in the boxes is dipped into a pail by a flat trowel-shaped dipper (Fig. 3, a) and then transferred to a barrel for transportation to the still. In the first season from six to eight dippings are made. The 10,000 boxes yield at each dip 40 barrels of "dip" or "soft gum," as it is reckoned in Alabama, to be of 240 pounds net weight. The flow is most copious during the height of the summer (July and August), diminishes with the advent of the cooler season and ceases in October or November. As soon as the exudation of the resin is arrested and the resin begins to harden under the influence of a lower temperature it is carefully scraped from the scarified surface and the boxes with a narrow keen edged knife attached to a long wooden handle (Fig. 3, b, c). In the first season the average yield of dip amounts to 280 barrels and of the hard gum or scrape to 70 barrels. The first yields 6½ gallons spirits of turpentine to the barrel of 240 pounds net, and the latter 31 pounds to the barrel, resulting in the production of 2,100 gallons spirits of turpentine and 260 pounds of rosin of higher and highest grades. The dippings of the first season are called "virgin dip," from which the finest quality of rosin is obtained, graded in the market as water white (WW) and window glass (WG). In the second year from five to six dippings are made, the crop averaging 225 barrels of soft turpentine and 120 barrels of scrape, making altogether about 1,900 gallons spirits of turpentine.

The rosin, of which about 200 barrels are produced, is of a lighter or deeper amber color, and perfectly transparent, of medium quality, graded as I, H and G. In the third and fourth years the number of dippings is reduced to three. With the flow over a more extended surface, the turpentine thickens under prolonged exposure to the air and loses some of its volatile oil, partly by evaporation and partly by oxidation. In the third season the dip amounts to about 120 barrels and the scrape to about 100 barrels, yielding about 1,100 gallons spirits of turpentine and 100 barrels of rosin of a more or less dark color, less transparent, and graded as F, E, and D. In the fourth and last year three dippings of a somewhat smaller quantity of soft turpentine than that obtained the season before and 100 barrels of scrape are obtained, with a yield scarcely realizing 300 gallons of spirits of turpentine and 100 barrels of rosin of lowest quality, classed as C, B, and A. After the fourth year the turpentine orchard is generally abandoned. Owing to the reduction in quantity and quality of the raw product, it is not considered profitable by the larger operators to work the trees for a longer time. It is only in North Carolina that the smaller landowners work their trees for ten or more successive seasons, protect the trees against fire, and after giving them rest for a series of years, apply new boxes on spaces left between the old chips—"reboxing."

DISTILLATION.

The process of distillation is carried on in the ordinary way, and requires care and experience to obtain largest quantities of rosin of highest grade and to guard against overheating. After heating the still, somewhat above the melting of the crude turpentine, a small stream of tepid water from the top of the condenser is conducted into the still and allowed to run until the end of the process. A large quantity of water runs over with the spirits of turpentine, which is collected in a barrel, where it separates from the water and is then immediately transferred into barrels. After the oil has ceased to run freely the heating of the still and the influx of water has to be carefully regulated. After all the spirits of turpentine has been distilled over, the fire is removed and the contents of the still are drawn off by a tap connected with the bottom. This residuum, molten rosin, is at first allowed to run through a wire cloth and is immediately strained again through coarse cotton cloth or cotton batting, made for the purpose, into a large trough, from which it is ladled into barrels. The legal standard weight of the commercial package is 280 pounds gross. A turpentine distillery on the basis of twenty crops produces on the average during the four years that the boxes are worked 2,400 casks or 120,000 gallons of spirits of turpentine and about 12,000 barrels of rosin or 2,800,000 pounds, the lowest grades, B and A, excluded, a total value of about $60,000 at average prices. The prices of spirits vary at present from 28 to 40 cents a gallon, even through the same season, according to supply and demand in the market. The average quotations on December 30, 1892, at Wil-

FIG. 4.—IMPROVED METHOD OF TURPENTINE ORCHARDING.

mington were 28 cents for spirits and $1.91 for a barrel of rosin down to grade C.

COST OF ESTABLISHING A PLANT AND WORKING THE CROPS.

Timber lands with the privilege of boxing the timber for a term of four years are rented at the rate of $50 per crop of 10,000 boxes, or 200 acres. The establishment of a plant for the working of twenty crops, or 4,000 acres of timber land, requires an investment of about $5,000, including the buildings, stills, machinery for pumping water, tools and teams. According to the statements of an experienced operator, the cost of working the trees of one crop during the four years, which is mostly done by the job—that is, the making and cornering of the boxes, inspecting the same, raking around the trees, chipping, dipping, scraping, hauling the crude turpentine to the still, including cost of barrels for spirits of turpentine and for the rosin and superintending the crop—amounts to about $2,300 per per crop, or $46,000 for the twenty crops. If to this amount the interest, 6 per cent. per annum, on the capital invested and the depreciation in the value of the plant during the four years is added, with some other incidental expenses (taxes, etc.), the cost of the production of the 120,000 gallons of spirits of turpentine and 12,000 barrels of merchantable rosin foots up to not less than $50,000.

A method of improving on the present practice by employing an earthen pot instead of the injurious "box" has been patented and practically introduced by J. C. Schuler, of West Lake, La. The arrangement is represented in Fig. 4, its main feature being an earthen pot which can be moved as the scar is lengthened, thus reducing the distance over which the resin has to flow, and with this the amount of volatilization and loss of spirits of turpentine. The method resembles that employed in France (see Report of Chief of Forestry, United States Department of Agriculture, 1892, page 347), and, though its general application in this country is not yet secured, it is certainly a step in the right direction.

Mr. Schuler admits that the first cost for providing the cups, putting them up, and removing them the second season raises the expense of working a crop of 10,000 cups for two seasons to $460, against $190 for cutting 10,000 boxes expended under the old system in working one crop for two seasons, all other expenses connected with the work being considered equal. On the other hand, Schuler claims that the difference is vastly overbalanced by the increased yield of crude turpentine obtained by his cup methods, amounting for one crop worked two years to 195 barrels, at $3.50 per barrel; after deducting the extra expense involved by his method, this would leave a net balance of $410 per crop in favor of the cup system. He also claims that this amount is still further augmented if the larger quantity of spirits of turpentine and the higher quality of resin obtained from the dippings under his system are taken into account. On the first point he says that fully one-eighth of the crude turpentine brought to the still from the boxes consists of chips, sand and other foreign matter, contaminations from which the product of the cups is entirely free. On the second point he refers to the high grades of rosin resulting from the distillation of the crude turpentine from the cups, which almost entirely classes with the highest and higher grades.

EFFECTS OF THE PRODUCTION OF NAVAL STORES UPON THE TIMBER, THE LIFE OF THE TREE AND THE CONDITIONS OF THE FOREST.

In the present management of the turpentine orchards in the Southern pine forests a great deal of crude turpentine is wasted, much of the valuable spirits of turpentine is lost by volatilization in passing over the long chip face on its way to the box, and much of the resin is lowered in its grade and value by oxidation consequent to exposure and by admixture of foreign substances—bark, coal, dust, etc. Concerning the effect of the tapping of the trees upon the timber, there exists no reason on physiological or anatomical grounds for considering it injurious, and the opinion held by many, that the qualities of timber are impaired by bleeding, finds no support when it is considered that the heartwood remains unaffected.

THE TURQUOISE MINES OF PERSIA.

THE British vice consul at Meshed says that the celebrated turquoise mines, near Nishapur, are believed to be the only mines in the world worth the name, which have been worked extensively, or which have produced the turquoise of perfect shape and color. On approaching the turquoise mines from the direction of Nishapur, after entering low hills and gradually ascending, there are two villages inhabited by the miners, which are on undulating ground about 5,000 ft. above sea level. After another gradual ascent for about a mile by a very good road, the foot of a modest hill about 1,000 ft. in height is reached. All the mines are on the south face of the hill, and from east to west, from the first to the last, the distance as the crow flies is not more than half a mile. But the hill consists of several ridges, separated by ravines, and to arrive at a mine within a stone's throw of another, may entail half an hour's journey up and down hill. Besides these underground mines, there are what are called khaki (earth) mines. There are three mines worked by lessees, but they are worked on a system bad in every way. At present, the superintendent employs only 100 miners at the three mines. These work in two reliefs, by night and by day. The consul gives a description of a visit he made to these mines, and states that he first visited the Reish mine, which is the only one worked on a large scale, or with vigor, and which produces the greater part of the turquoises at present sent to market. It is near the top of one of the highest ridges, at an altitude of about 6,000 ft. above sea level. The entrance of the mine is a hollowed-out cave, about twelve yards across, with a vertical shaft some five yards in diameter. At the time of his visit, two men were reclining at the mouth of this shaft with their backs against the wall of the cave, and turning with their bare feet a rickety wooden wheel, which brought up the debris from below in a small sheepskin bag. This bag was received by a third man, who unhooked, emptied, and reattached it. The other two men removed their feet, and the bag went down with a run some 40 ft., where three other men were similarly engaged on a ledge in the shaft. The mine itself is some 80 or 90 ft. from the surface, but the descent was impracticable in boots. The miners first descend by means of a narrow diagonal tunnel, and then scramble down the rough sides of the shaft. At the mouth of the cave, which is on the precipitous hillside, half a dozen men were seated close together on a ledge, breaking with small hammers the fragments of rock as they were brought up from below. When a turquoise was discovered, it was placed on one side in its rough state incased in rock. Although this mine is very productive, and the turquoises of good shape, their color soon goes. From the Zaki and one or two other mines a few fair turquoises are obtained, and in the detritus on the hill and down near the village a good stone occasionally comes to light. The work in these khaki mines is easy and light, and generally undertaken by women, old men and children, who pay a kran each day for the privilege. All they have to do is

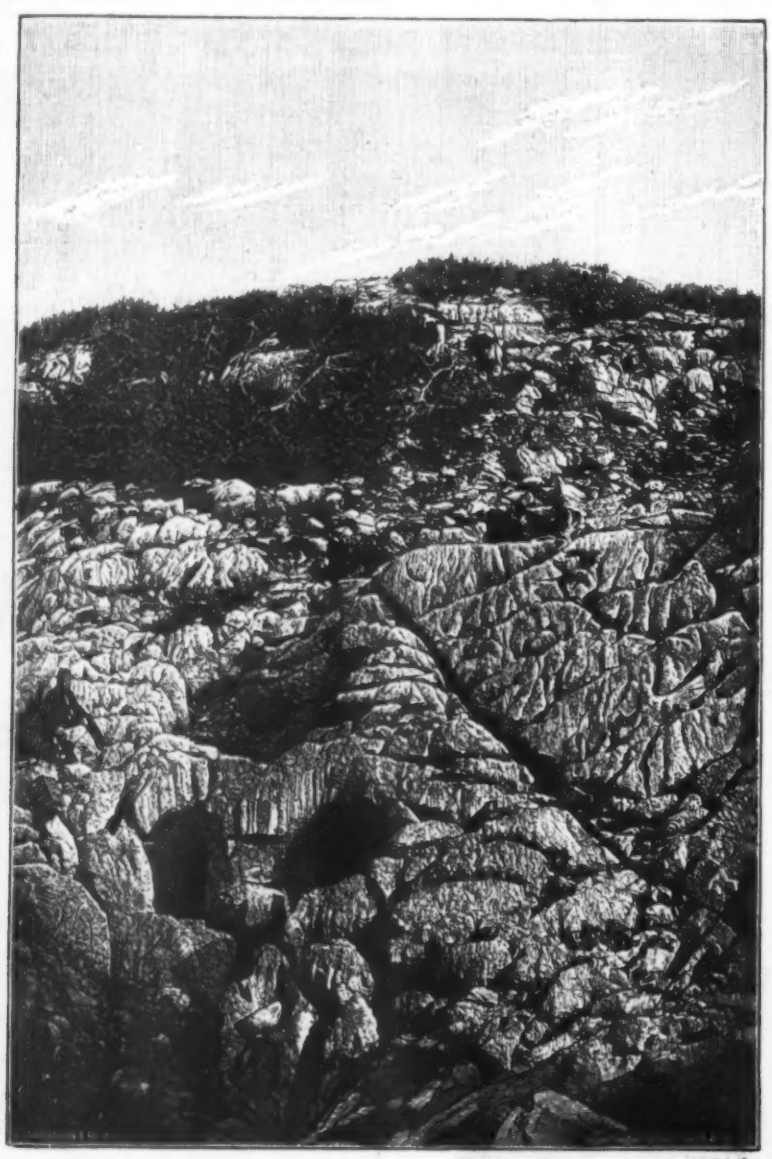
to dig up 2 or 3 ft. of the soft soil and to sift it. They find, perhaps, half a dozen turquoises in a day. Although really good turquoises are rare, an abundance of imperfect and bad stones are turned out and are largely bought up, for all Orientals prize them, and the very poorest like to possess even a green and spotted one set in a tin ring. Notwithstanding the fact that good stones are rarely found at present, it is more than likely that the hill contains them in abundance. Only an infinitesimal portion of the south side of it has been opened, and yet almost wherever they dig the turquoise in some shape or other turns up. Even before the hill is reached the visitor sees the ground strewn with the mineral in every stage of composition. In one of the early stages it is a sort of cream colored chalk, which is said to have medicinal properties, and which the people eat with apparent zest. Then it is seen like hard chalk, and then embedded in the fragments of rock lying around, and of various shades of blue and green. Fragments of turquoise may be picked up at the mines, the size of a walnut, but of no value whatever, being full of flaws, and of a dirty light green color. All the way up the hill the ground is littered with these fragments, and on entering the mouth of any of the large mines, the roof and walls appear to be seamed with the turquoise. Some of the stones now found look excellent at first, but the color in most cases soon fades, or a green tinge is developed, or spots appear on them. Some of these white spots can only be detected at first with a glass, and then as a mere speck, but in time they may expand and spread right across the stone. The color of most faded turquoises can be temporarily revived by dampness, and this should be borne in mind by all purchasers. The vice consul says that at the mines he was offered a large number of turquoises of good color, but in every case the vender brought his stone in his mouth, and when he fancied himself unobserved, slipped it into his hand, and then promptly offered it for sale. In Meshed, no one would dream of buying a turquoise of good color without possessing it first for some days. The turquoises as soon as they are cut are nearly all sold at once for export. Seven or eight years ago one could obtain in Meshed really good turquoises of perfect shape, good color, fair size, and without a flaw, for a few shillings each, and that without trouble, while at present it is almost impossible to obtain such a stone at any price, and after weeks of searching. Turquoises are at the present time far cheaper at Tiflis and Constantinople than at Meshed, and even in India they are cheaper.—Journal of the Society of Arts.

DO NOT put rubber goods in a shop window exposed to the sun, or they will quickly perish. Hose and tennis balls are soon spoilt by heat.

LIMESTONE FORMATIONS.

ON high mountains the limestone that is exposed to the atmosphere takes peculiar shapes; this is caused partly by the chemical decomposition of the water that settles on it and partly by erosion, particularly where snow lies for a long time on gentle declivities and ridges near the snow line and thaws gradually. In the Alps, at a height of 5,300 ft. and even 6,200 ft. to 8,500, we often see bare rocks extending almost horizontally for long distances, which are badly furrowed and crossed by deep, washed out channels, so that they look like the surface of a stormy sea that has been petrified suddenly leaving stone peaks where the waves had been. These rocks, which are called "karrenfelder," are so seamed and cut up by fissures yards deep that it is impossible, under any circumstances, to make one's way over them. The rock between the fissures is sometimes as sharp as the edge of a knife and sometimes it is so cut by cross fissures that it looks like a comb the teeth of which have been broken off irregularly; a stone sea of splinters and teeth full of bizarre forms that frequently remind one of the glacial needles.

There are in these rocks many deep holes like the craters of volcanoes and steep passages that are lost in the depths, and there are broad, kettlelike basins the bottoms of which are perforated like sieves. Although



"KARRENFELDER" IN THE DACHSTEIN MOUNTAINS.

(From a photograph taken by F. Simony.)

chaos generally rules in such places, sometimes it seems as if a certain law had governed the erosion, giving the formation such a strong resemblance to the cells of the honeycomb in beehives that the herdsmen call these rocks "Steinwaben" or stone combs. The whole thing is a picture of the most terrible destruction on a small scale.

All this is the result of disintegration, of imperceptible but effective wearing away by water from the glaciers, snow and rain, by the scorching of the sun, which makes the rock brittle, and by freezing, that causes the rock to crack and split off; in fact, it is the result of the constant exposure of the stone to the atmosphere. The solubility of the lime, which causes the formation of the furrows, is another matter, and the "karrenfelder" are generally formed of soluble stone. As not a particle of fruitful earth adheres to these friable rocks, the reflected heat from which is quite unbearable in summer, and as the water which collects from the melting snow in the spring, or from the heavy rains, rushes through the fissures and holes, disappearing in the bowels of the mountain, it will be easily understood that these rocks are entirely unfitted for sustaining vegetation of any kind, even the least exacting; so far as the eye can reach everything looks desolate and sad, for where there are no honeybearing flowers there are no buzzing bees, no fluttering butterflies, no chirping beetles, where not even a blade of grass nor a tuft of moss can hide itself in the cracks and fissures there will be no little animals; even birds seem to avoid these desolate places, which may very aptly be called the desert of the Alps.

To a height of 5,200 ft. above the level of the sea these "karrenfelder" are often partly covered with Alpen roses, juniper trees, bushes, or dry, lifeless grass, or, in some instances, even with more luxurious Alpine plants. In favorable locations this vegetation occasionally collects under the weather beaten rocks, forming humus. On account of the solubility of the "karren" surfaces in water and the tendency of the cracks, funnels and craters in the rock to suck in the water, these mountains are very rich in water, and springs and even high waterfalls—some of which are permanent and some periodical—are very numerous. Karren formations are found in many places in Switzerland, but occur with greatest frequency in the Austrian limestone mountains, the Salzburger Mountains, in the Tennengebirge, the Dachstein Gruppe and in the Todten Gebirge.—Der Stein der Weisen.

SINS OF MODERN EDUCATION.

"TRAIN up a child in the way he should go" is one of those pieces of wholesome but general advice that needs no claim of inspiration to insure it against contradiction. But parents and educators are still wrestling, as they were, doubtless, in Solomon's time, to find out which way the child should go and how he should be trained to go in that way. Dr. Guglielmo Ferrero contributes to the School Journal, says the Literary Digest, an article in which he speaks strongly against the "whimsicality of education," in which the impulse of the parent rather than any definite principle determines what the child may or may not do. This is "the first sin" of modern education. But "the cardinal sin" is that we look upon the child from the standpoint of an adult and fail to look at things through his eyes. On this point Dr. Ferrero writes as follows:

"Another sin of which educators are guilty is that they, without being conscious of it, cause the children pain by not taking them seriously enough in certain matters and again too seriously in certain other ones. The child mind constantly produces the strangest wishes and fantastic desires, which adults, often in the presence of the children, laugh at without recalling that they themselves also were not born as complete men and women. Yet this frivolous scoffing of adults wounds the child heart deeply, and he feels humiliated and intimidated thereby. The child, too, has ambitions. And as he lives in a period of lively intellectual development during which he produces ideas only with much labor, raises doubts, and puts questions, he is excited and inspired by everything he thinks and does; he loses confidence in himself when he finds that the fruit of his reflection and laborious mental work is received with laughter by those who stand on a higher intellectual plane. I shall never forget the expression of painful shame which I once saw on the face of an eight-year-old boy who had for the first time written a letter to his relatives and given it to his father to look over. The letter was full of mistakes, full of naive turns and errors which threw the father into a fit of laughter. But the poor boy, who had spent much care and labor on the letter, at last could not stand the torture any longer; he tore the letter from his father's hands and ran into another room, where he hid himself and cried bitterly. True, not all children are as easily excited as this boy; but all have a more or less developed ambition, and when this is injured they suffer unspeakable pains. And what educational advantage is gained thereby? Absolutely none, not a scintilla of one."

It is true, Dr. Ferrero observes, that the elasticity of desire which we call caprice in the child must in time be adjusted to the monotonous rhythm of social life; but he does not think that this labor of adjustment should be forced on a child until the ninth or tenth year. He continues:

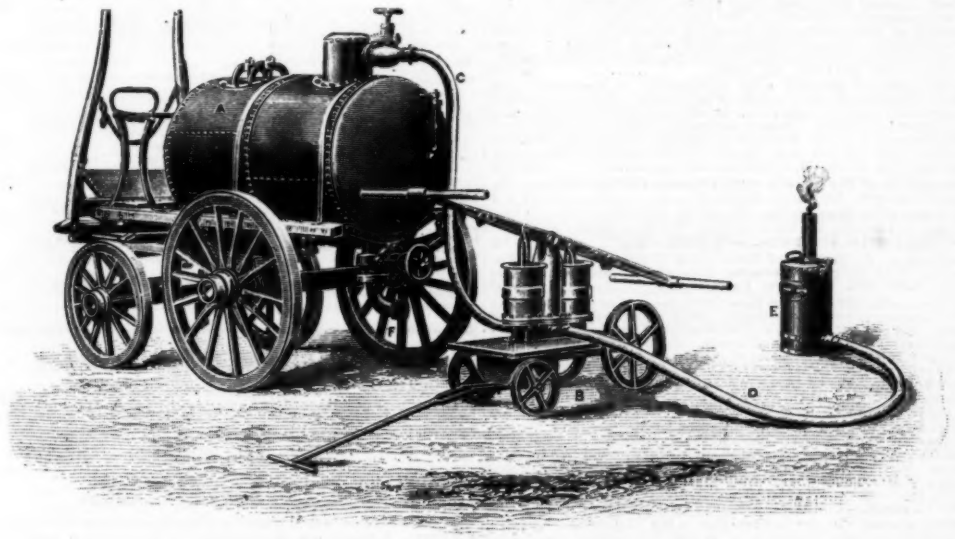
"To be sure, indulgence of so-called whims and the impulsiveness of children must not go beyond certain limits, which, however, cannot possibly be determined by general principles. Hence a model father and model mother should by constant reflection and according to various experiences determine for each individual case where to draw the line. Instead of this, something else happens usually. The 'capriciousness' and impulsiveness of the child finally produce in many parents, even in the most loving ones, a state of indefinite excitability which unconsciously prompts them to oppose the wish of the child. In many families there is a sort of bitter struggle between parents and children, which does not at all exclude mutual love, which, however, transforms the mutual will-inclinations into two like poles which repel each other. If the boy wants to eat, he is told immediately that it is too early or too late, and that he must wait. If he wants to take a walk, it is said that the weather is too disagreeable or too cool, that he had better stay at home. Frequently there follows in the mind of the father upon the first opposition a feeling of remorse, and in consequence he grants the wish; but, as a general rule, whenever a child utters a wish in a somewhat lively manner or somewhat unexpectedly, no matter how reasonable and just it is, the first reaction in the fatherly or motherly heart is refusal. This malicious tendency is most frequently met with in nervous persons who at present, unfortunately, form so large a part of the intelligent classes in civilized nations, and at bottom it is nothing but an excitability produced by physical and moral disturbances caused by the whims of children. In consequence of this excitability the mind is gradually evil disposed and controlled by an indefinite and half unconscious instigation to thwart the child.

"On the other hand, we take children too seriously when we want to compel them to observe all the complicated formalities of social intercourse. It may be said that three-fourths of the education which children receive of their parents consists in initiation in the forms of intercourse. Why is this done? Why is the greater part of the time wasted in teaching children when and where to take off their hats, how to behave under given circumstances or in the presence of certain persons, how to eat, how to walk? Why are the children tormented with the inculcation of social etiquette and ceremony? All these things ought to be

known, sure enough, but the learning of them costs much labor at the age before the eighth or ninth year, while at a later period they are acquired with the greatest ease. All these rules, though universally useful, still are without any great significance, for the external forms have no organic connection of any sort with the sentiments which they are to express. What is the reason, for instance, that the lifting of the hat signifies respect of persons? Hence, since these actions have no rational basis by which the child might account for their significance, he can learn them only by much practice. And this practice is all the more difficult at the age when the mind is restless and distracted and the will less concentrated and less master of itself. The child frequently forgets and violates some form of this complicated and burdensome ceremonial because his attention is turned from it by his want of movement, his curiosity, his play impulse. And in a case of this kind his parents pour reproach over him as if he had done some grievous wrong. But why are parents not satisfied to let the child so conduct himself that he does not bother adults? and why do they not limit the observation of forms of etiquette to a minimum? Why will they force the tender limbs and undeveloped mind of the youthful creature into the fetters of the ceremonial which we adults even find sometimes too severe and too burdensome? What difference does it make that the boy moves about frank and free, without the observation of conventional forms, as long as he is healthy and cheerful and grows strong and vigorous in body and mind?"

MERRYWEATHER'S PNEUMATIC CESSPOOL EMPTYING APPARATUS.

THE accompanying illustration shows a complete apparatus for emptying cesspools, recently constructed by Messrs. Merryweather & Sons, Limited, London, for use at Pokesdown England. The apparatus, as will be seen, consists of a tank or receptacle for sewage, with dome and connecting pipe for producing a vacuum in the receptacle. The tank is provided with a manhole for cleansing purposes, and inlet and outlet sluice valves. A gage glass is also fitted, which gives indication of the quantity of matter in the receptacle. The whole is mounted on strong springs and patent axles provided with four wheels, a driver's seat and



MERRYWEATHER'S CESSPOOL EMPTIER.

footboard are also fitted. The vacuum pump is of special design, to be worked by two men, of necessary power to create a vacuum in the tank. It is mounted on a platform and provided with four iron wheels. A flexible air pipe is supplied for connecting the tank to the air pump, and a similar pipe for the conveyance of the gases to the stove, where they are burnt.—The Engineer.

ON THE USE OF SALICYLATE OF SODIUM AND BROMIDE OF POTASSIUM IN THE IRRITABLE TEMPER OF CARDIAC DISEASE AND GOUT.

LAUDER BRUNTON writes of this topic in the London Practitioner for July, 1896. He remarks that an irritable temper is a great misfortune, not only to its possessor, but to his friends and acquaintances. It may be natural or acquired, permanent or temporary. In many people an irritable temper is hereditary, but it may be brought very much under control by constant effort; while, in others, a temper which was not originally bad may become excessively irritable from lack of control, and the habit of yielding to it on slight provocation. But the temper may become irritable from various physical conditions, such as continued ill health; or it may become temporarily irritable, as in gouty people shortly before an attack of gout. Not infrequently the explosions of temper which occur on very slight provocation are really due to the irritation produced by an accumulation of small irritations, bodily or mental, which have been gradually working up the patient into a state of excitement, and this feeling vents itself in an explosion quite out of proportion to the irritation which has simply let it loose but has not really produced it. Thus, an unfortunate clerk or office boy may be roundly abused for some very slight slip on his part, while the wrath poured out by his principal is really due to business worries or personal annoyances altogether unconnected with the subordinate's fault.

Continuous physical discomfort likewise tends to cause an accumulation of irritability, which finally finds vent in an explosion of temper, and an angry person sometimes blames himself for a moral wrong when he is really suffering from physical disorder.

The late Dr. Milner Fothergill used to tell a story of a very irritable old lady who frequently retired to her own room to pray for grace to control her temper, when what she really needed, in Dr. Fothergill's opinion, was a dose of potash to relieve her gout.

In some gouty people twenty grains of bicarbonate of potash, with ten or twenty of bromide of potassium, taken when the feeling of irritability comes on, frequently soothes it, and it has the further effect of lessening the worry even in those who are not irritable. If this "temper powder," as Brunton calls it, be taken when some irritating occurrence takes place, or some depressing news is heard, it appears to take away the sting of either, so that, in place of being much worried thereby, the person feels as if he had slept over the bad news or the worry, and is able to obtain relief by turning his attention to something else.

Irritability of temper does not occur in all cases of cardiac disease, but it is by no means an infrequent symptom. The late Mr. Mark Morrow, steward of St. Bartholomew's Hospital, one of the acutest observers that Brunton ever came across, told him that when a patient came down to the office at 11 o'clock at night and insisted upon his immediate discharge from the hospital, he knew that it was a case of cardiac disorder.

Some time ago a little girl, the daughter of a clergyman, began to show symptoms of unwonted irritability of temper. She was peevish, fretful and quarreled with her brothers and sisters. This was looked upon as sinful and the child was reproved or punished accordingly, until one day a doctor, who was a friend of the family, happened to put his ear to her chest and discovered that she was suffering from severe mitral regurgitation, with dilated heart.

In a paper published in the Practitioner in February, 1894, the author mentioned that unwonted irritability of temper was sometimes the precursor of a headache, and in that paper described the beneficial action of bromide of potassium and salicylate of soda in relieving headache. It occurred to the writer that in case of heart disease the irritability might be relieved by the use of these drugs, and he has lately been trying them with a considerable amount of success. The subjective feelings of the patients have been improved, and, while they previously denied any improvement under the use of digitalis and other cardiac remedies, even although these had improved the objective condition, they acknowledged, after a few doses of bromide and salicylate, that they felt better. The mode of action of the bromide is readily enough understood, as it is a simple sedative to the nerve centers. The mode of action of salicylate is not so clear, although the admirable researches of Dr. Haig seem to point to its action indirectly by the removal of uric acid.

Lessened irritability of temper is useful not only to the patient but to his friends, and it is sometimes easier to treat patients by giving physic to their friends than by giving it to themselves; and frequently the other members of a family, friends or society have their appetites spoiled, their digestion impaired, and their pleasure in life destroyed by the irritability of one or two individuals; and anything that will lessen this irritability will do more to improve the health of the others than any amount of drugs can do of themselves.—The Therapeutic Gazette.

"INSUSCEPTIBILITY" TO VACCINATION.

IN the last report of the medical officer of the local government board it was stated that among 88,875 successive vaccinations by the officers of the board, whether with humanized lymph or with calf lymph, no case of insusceptibility had been met with; that is to say, in no case of primary vaccination had the individual been vaccinated three times unsuccessfully. The statement has caused some expressions of astonishment, especially as it was accompanied by another to the effect that no less than 1,983 certificates of insusceptibility had been granted by medical practitioners in England and Wales during the last year reported on. There is, therefore, some interest in noting what has been the result at other than government public stations, where, presumably, the operation has been performed with perfectly fresh—that is, unstored—lymph. We now note that Mr. O. Lowsley, public vaccinator for Reading, recently announced to the Reading board of guardians that out of 14,000 children whom he had vaccinated he had "never found a case of insusceptibility." Although "insusceptibility" to vaccination is admitted by law, it really becomes doubtful whether it has more than a legalized existence.—Lancet.

ELECTRICAL SCIENCE AND THE MYSTERY OF PHOSPHORESCENCE.

BIT by bit, says a writer in the Philadelphia Evening Telegram, the old mystery which surrounds the subject of the emission of light by phosphorescent substances is being unraveled. Uncanny stories of corpse lights and will-o'-the wisps may continue to furnish food for the folkchrist, and the fabled lamp of Aladdin will flourish forever in story. Science, when she dissipates a mystery, always ends by leaving the heart of the fable untouched. Nevertheless, she does explore the facts that lie at the base of romance, and sometimes deals cruelly with them. Of the out-of-the-way corners of science none has been more tempting than that which is concerned with the strange property of giving out light without heat. To the alchemists are due the beginnings of real discovery. Did not Krafft evolve from a hideous brew of organic matter the material afterward isolated as the chemical element phosphorus? Its slow oxidation in moist air produces the pale gleam familiar to every schoolboy as belonging to lucifer matches.

Did not an obscure shoemaker of Bologna discover that, by heating in a furnace, mixed with a little flour meal, a certain powdered spar from Monte Paterno, there was yielded a chalky powder having the property of shining in the dark after having been exposed to sunlight? Here was a prime mystery. No combustion, no waste of substance—in short, a mere bottling up of daylight, to emit it again with a feeble, nightlong gleam when all around was dark. To the famous phosphorus of Bologna succeeded the more brilliant phosphorus of John Canton, concocted of oyster shells calcined with charcoal or meal in a close crucible. And the phosphorus of Canton is in our day superseded by luminous paint, used for clock faces and match box tops, that need to be visible in the blackest of night. Science tells us that, after all, these are only sulphides of the alkaline earths; but, be that so, those that shine best are never pure sulphides.

Closely akin to phosphorescence is the property of fluorescence, the nature of which, though some of the facts were known to Goethe, to Brewster and to Herschel, was first explained by Sir George Stokes. A chip of horse chestnut bark, a crystal of quinine, or a grain of the dyestuff eosin, is dropped into water—acidulated, it may be, to hasten solution—and behold the liquid exhibits on the surface exposed to light a most beautiful coloring, blue, green, or orange, as the case may be. That a liquid should possess a surface color where the light first strikes it, and that color be quite different from the color of the liquid itself, as seen by transmitted light, is a fact that fascinates by its paradoxical nature. Why should the green liquid made by macerating young green leaves in alcohol shine with a deep red color on its surface? Fluorspar—the "bluejohn" of the miners—exhibits a similar possession; for its surface color is different from the tint of the mineral. Stokes showed that this surface tint is due to the property of the liquid in transforming into visible colored light some of the invisible waves which are always present in daylight, and from their position in the spectrum are called ultra-violet waves; being waves of shorter length and higher frequency of vibration than the shortest of visible waves, namely the violet. This transmutation of invisible into visible Stokes named fluorescence.

Then followed the discovery that these waves which excite fluorescence as above described, and which are the very waves that are most active photographically, are also the waves that are most active in producing phosphorescence in the luminous paints. Here was afforded a very broad hint that both fluorescence and phosphorescence might be, like photographic actions, chemical phenomena in their essence. The patient Becquerel, using instrumental methods for observing substances in the dark, after they had been exposed to light, and especially to ultra-violet waves for a brief fraction of a second, showed that phosphorescence, so far from being a rare property, is possessed by innumerable kinds of stuffs. Chalk, porcelain, glass of various sorts, and rubies, shine for a twentieth of a second or so. Some artificial chemical crystals, notably the green compounds of uranium, shine for but 1-100th of a second or less. Regarded from the time standpoint, the difference between phosphorescence and fluorescence is a mere difference in degree; the one is a persistent, the other a transient transformation of the waves. On the top of these discoveries of a generation ago came the observations, notably those of Crookes, that fluorescence and phosphorescence are stimulated by electric discharges in vacuo much more brilliantly than by even the brightest sunlight. The phosphorescence excited by the discharge from the cathode or negative pole in the most attenuated vacuo possesses many striking and brilliant features. Lastly come the memorable researches of Renard and Roentgen, who have found in the emanations that proceed from properly exhausted vacuum tubes, when electrically stimulated, rays that will penetrate paper, wood, flesh, and even opaque sheets of aluminum, and will, nevertheless, make their presence known by causing fluorescence and by their photographic action. Roentgen's worldwide discovery of the past year seems almost like an adverse species of fluorescence—a transmutation from the lower to the higher order of waves. And, indeed, H. Becquerel has shown that the highly fluorescent compounds will, after exposure to light, give off for many hours visible waves which closely resemble Roentgen's rays in their power of penetration through aluminum and other opaque materials and in their photographic action. So to the phenomena of phosphorescence and fluorescence we have now a hyperphosphorescence to record, and if Wiedemann and his collaborators have half solved the mystery of phosphorescence by showing that it is due to a sort of limited chemical decomposition of molecules under the influence of electric or luminous simulation, the mystery is certainly no less bewildering than before; the explanation is itself no less a mystery, needing in turn to be explained.

SELECTED LIST OF BOOKS ON

CIVIL ENGINEERING.

Applied Mechanics and Resistance of Materials. Showing Strains on Beams as determined by the Testing Machines of Watertown Arsenal and at the Massachusetts Institute of Technology. Practical and Theoretical. Designed for Engineers, Architects and Students. By Prof. G. Lanza. With hundreds of illustrations. Revised. 8vo, cloth..... $7 50

Bridge. The Washington Bridge (known during construction as the "Harlem River Bridge" and "Manhattan Bridge"). A Description of its Construction. By William R. Hutton. Illustrated with 63 plates. 100 pages of text. Quarto, cloth. N. Y..... $8 00

Bridges. A Practical Treatise on the Construction of Bridges. By T. C. Fidler. 420 pages. 230 illustrations. 26 full-page plates. 8vo, cloth..... $7 50

Bridges. The Designing of Ordinary Iron Highway Bridges. By J. A. L. Waddell, Consulting Engineer, Kansas City, Mo., also engineer in charge of the Western office of the Phœnix Bridge Co. and the Phœnix Iron Co., formerly Professor of Civil Engineering in the Imperial University of Japan, etc..... $4 00

Bridges. Plate Girder Railway Bridges. By Maurice Fitzmaurice. 8vo, cloth. 104 pages. Plates. London. 1895.... $2 40

Bridges. Wooden Trestle Bridges. According to the Present Practice on American Railroads, Treating of Pile Bents, Pile Drivers, Framed Bents, Floor System, Bracing Trestles of all kinds, Iron Details, Connection with Embankment and Protection against Accidents. Field Engineering and Erection, Preservation and Standard Specifications, Bills of Material, Records and Maintenance, Working Drawings. By Wolcott C. Foster, C.E. Second edition, revised and enlarged. 4to, cloth..... $5 00

Bridge Piers. Notes on Cylinder Bridge Piers and the Well System of Foundations. Especially written to assist those engaged in the construction of Bridges, Quays, Docks, River Walls, Weirs, etc. By John Newman. 136 pages. 8vo, cloth..... $2 50

Calculus. An Elementary Treatise on the Calculus for Engineering Students. With numerous problems worked out. By John Graham. 12mo, cloth. 276 pages. London and N. Y., 1896..... $2 00

Civil Engineer's Field Book. Designed for the use of the Locating Engineer, Containing Tables of Actual Tangents and Arcs, expressed in chords of 100 feet for every minute of intersection, from 0° to 90°, from A 1° curve to A 10° curve inclusive. Also, Tables of Formulæ applicable to Railroad Curves and the location of Frogs, together with Radii, Long Chords, Grades, Tangents, Natural Sines, Natural Versed Sines, Natural External Secants, etc. With Explanatory Problems. By Edward Butts. 12mo, morocco flaps..... $2 50

Civil Engineering. An Elementary Course of Civil Engineering. For the Use of the Cadets of the United States Military Academy. By J. B. Wheeler. With many fine wood engravings. 8vo, cloth..... $4 00

Civil Engineering. A Field Book for Civil Engineers. By Daniel Carhart. Pocketbook form. 18mo, gilt edges. 281 pages..... $2 50

Civil Engineering. A Manual of Civil Engineering. By W. J. M. Rankine. With numerous Tables and Illustrations. 8vo, cloth..... $6 50

Civil Engineering. A Treatise on Civil Engineering. Revised and edited, with additions and new plates. By Prof. De Volson Wood. With an Appendix and complete Index. New edition, with Chapter on River Improvements. By E. A. Mahan. 8vo, cloth..... $5 00

Civil Engineering. A Treatise on Civil Engineering. By W. M. Patton. 8vo, cloth. 1,054 pages. Illustrated. N. Y., 1895..... $7 50

Earthwork Slips and Subsidences Upon Public Works. Their Causes, Prevention and Reparation. Especially written to assist those engaged in the construction or maintenance of Railways, Docks, Canals, Roads, Waterworks, River Banks, Reclamation Embankments, Drainage Works, etc. By John Newman, C.E. 234 pages, tables and index. 12mo, cloth..... $3 00

Elasticity and Resistance of Materials of Engineering. For the Use of Engineers and Students. Well illustrated. Containing the latest Engineering Experience and Tests. By Prof. W. H. Burr, C.E. 772 pages. Fourth edition, revised and enlarged. 8vo, cloth..... $5 00

Engineer's Pocketbook of Mensuration, Trigonometry, Surveying, Hydraulics, Hydrostatics, Instruments and their Adjustments, Strength of Materials, Masonry, Principles of Wooden and Iron Roof and Bridge Trusses, Stone Bridges and Culverts, Trestles, Pillars, Suspension Bridges, Dams, Railroads, Turnouts, Turning Platforms, Water Stations, Cost of Earthwork, Foundations, Retaining Walls, etc.; in addition to which the elucidation of certain important principles of construction is made in a more simple manner than heretofore. By John C. Trautwine. Fully illustrated. This is one of the best books for engineers, and every one should possess a copy..... $5 00

Engineer's Pocketbook. A Pocketbook of Useful Formulæ and Memoranda for Civil and Mechanical Engineers. By Guilford L. Molesworth, Mem. Inst. C.E., Consulting Engineer to the Government of India for State Railways. 32mo, roan...$2 00

Engineer's Pocketbook. Giving Tables, Rules and Formulas pertaining to Mechanics, Mathematics and Physics, Architecture, Masonry, Steam Vessels, Mills, Limes, Mortars, Cements, etc. By Charles H. Haswell, Civil, Marine and Mechanical Engineer. 900 pages. Leather, pocketbook form..... $4 00

Engineering Contracts and Specifications, including a brief Synopsis of the Law of Contracts, and Illustrative Examples of the General and Technical Clauses of various kinds of Engineering Specifications. Designed for the Use of Students, Engineers and Contractors. By J. B. Johnson. 8vo, cloth. 417 pages. N. Y., 1895..... $4 00

Engineering Materials. By R. H. Thurston. Part I. Non-Metallic Materials, Stone, Timber, Fuels, Lubricants, etc. ...$3 50
Part II. Iron and Steel..... 5 00
Part III. Non-Ferrous Metals..... 4 00

Engineering. Spon's Dictionary of Engineering, Civil, Mechanical, Military and Naval, with Technical Terms in French, German, Italian and Spanish. Complete in eight volumes, containing 3,132 pages, 7,414 engravings. 8vo, cloth..... $40 00
Also, furnished in 97 parts. Paper cover. Per part..... 40c.

Engineering. A Supplement to Spon's Dictionary of Engineering, Civil, Mechanical, Military and Naval. Complete in three volumes. 8vo, cloth..... $15 00
Also, furnished in 18 parts. Paper cover. Per part..... 75c.

Field Engineering. A Handbook of the Theory and Practice of Railway Surveying, Location and Construction, designed for Classroom, Field and Office Use, and containing a large number of Useful Tables, original and selected. By William H. Searles. This volume contains many short and unique methods of Laying Out, Locating and Constructing Compound Curves, Side Tracks, and Railroad Lines generally. It is also intended as a Text-Book for Scientific Schools. Pocketbook form. 12mo, morocco...$3 00

Foundations. Practical Treatise on Foundations. By W. M. Patton. 21 fullpage plates, illustrated. 400 pages. 8vo, cloth..... $5 00

Harbors. Principles and Practice of Harbor Construction. By William Shields. 300 pages. 97 illustrations. 1895..... $5 00

Highway Construction. Designed as a Text-Book and Work of Reference for all who may be engaged in the Location, Construction and Maintenance of Roads, Streets and Pavements. By Austin T. Byrne. Third edition. 8vo, cloth..... $5 00

Leveling and Its General Application. By Thomas Holloway. This work is written solely for the beginner and the uninitiated, in the belief that they cannot do better than follow the teachings of one in actual practice. 147 pages. 58 illustrations. 8vo, cloth..... $2 00

Lighthouses. Ancient and Modern Lighthouses. By Major D. P. Heap, Corps of Engineers, U. S. Army. Illustrated....$5 00

Logarithms. Computation Rules and Logarithms, with Tables of other useful functions. By Silas W. Holman. 8vo, cloth. 73 pages. London, 1896..... $1 00

Masonry. A Treatise on Masonry Construction. Containing Materials and Method of Testing Strength, etc.; Combinations of Materials—Composition, etc.; Foundations—Testing the Bearing Power of Soils, etc.; Masonry Structure—Stability against Sliding, Overturning, Crushing, etc. Complete in one volume of about 500 pages, with 125 illustrations and eight or ten folding plates. By Ira O. Baker. Ninth edition. 8vo, cloth..... $5 00

Materials of Construction. A Text-Book for Technical Schools, condensed from Thurston's "Materials of Engineering." Treating of Iron and Steel, their ores, manufacture, properties and uses; the useful metals and their alloys, especially brasses and bronzes, and their "kalchords;" strength, ductility, resistance and elasticity, effects of prolonged and oft-repeated loading, crystallization and granulation; peculiar metals, Thurston's "maximum alloys;" stone; timber; preservative processes, etc. By Prof. Robert H. Thurston, of Cornell University. Many illustrations. Thick 8vo, cloth..... $5 00

Mechanics of Engineering. Comprising Statics and Dynamics of Solids, the Mechanics of the Materials of Constructions or Strength and Elasticity of Beams, Columns, Shafts, Arches, etc., and the Principles of Hydraulics and Pneumatics with Applications. For the use of Technical Schools. By Prof. Irving P. Church. 8vo, cloth..... $6 00

Mechanics: The Principles of Mechanism. By Prof. S. W. Robinson. 8vo, cloth. Illustrated. Over 300 pages. N. Y., 1896..... $3 00

Mechanics. Nystrom's Pocketbook of Mechanics and Engineering. Revised, corrected and greatly enlarged, with addition of original matter. By William Dennis Marks. Twenty-first edition, further revised and corrected by Robert Grimshaw. 18mo, leather, pocketbook form. 675 pages. Illustrated. 1895....$3 50

Mechanical Engineer's Pocketbook. A Reference Book of Rules, Tables, Data and Formulæ for the use of Engineers, Mechanics and Students. By William Kent. 12mo, morocco flap, pocketbook form. 1,087 pages. N. Y..... $5 00

Popular Engineering: Being interesting and instructive examples in Civil, Mechanical, Electrical, Chemical, Mining, Military and Naval Engineering graphically and plainly described, and specially written for those about to enter the Engineering Profession and the Scientific Amateur. With chapters on Perpetual Motion and Engineering Schools and Colleges. By F. Dye. 8vo, cloth. 469 pages. Illustrated. London, 1895..... $3 00

Railways. The Economic Theory of the Location of Railways. An Analysis of the Conditions controlling the laying out of Railways to effect the most judicious expenditure of capital. By Arthur M. Wellington. 8vo..... $5 00

Railways. Field Book for Railway Engineers. Containing Formulas for Laying Out Curves, Determining Frog Angles, Leveling, Calculating, Earthwork, etc., together with Tables of Radii, Ordinates, Deflections, Logarithms, etc. By John B. Henck. Entirely rewritten and revised. 12mo, leather, tuck. N. Y., 1896..... $2 50

Railways. Formulas for Railway Crossings and Switches. By J. Glover. 32mo, cloth. Illustrated. 29 pages. London and N. Y., 1896..... $1 00

Railways. Manual for Railroad Engineers and Engineering Students. Containing the Rules and Tables needed for the Location, Construction and Equipment of Railroads, as Built in the United States. By George L. Vose, Professor of Civil Engineering in Bowdoin College. With 105 woodcuts and 31 large plates. 8vo..... $12 50

Railroad Engineer's Field Book. An Explorer's Guide, especially adapted to the use of Railroad Engineers on Location and Construction, and the Needs of the Explorer in Making Exploratory Surveys. By H. G. Godwin. Morocco flap..... $2 50

Strains in Framed Structures, with numerous practical applications to Cranes; Bridge, Roof and Suspension Trusses; Braced Arches; Pivot and Draw Spans, Continuous Girders, including complete treatment of the Cantilever, etc.; also, Determination of Dimensions and Designing of Details, Specifications and Contracts. Complete Designs and Working Drawings. Illustrated with hundreds of cuts and 35 full-page and 14 folding plates. By Prof. A. Jay Du Bois. 4to, cloth..... 10 00

Strength of Beams and Columns. A theoretical and practical treatise on the Strength of Beams and Columns, in which the ultimate and the elastic limit strength of Beams and Columns is computed from the ultimate and elastic limit, compressive and tensile strength of the material, by means of formulas deduced from the correct and new theory of the transverse strength of materials. By Robert H. Cousins..... $5 00

Strength of Materials and Theory of Structures. By Henry T. Bovey. 830 pages. 8vo, cloth..... $7 50

Strength of Materials. Including their Elasticity and Resistance to Impact. By Thomas Box. Third edition. 325 pages. 27 full-page and folding plates. 8vo, cloth..... $7 25

Stresses. Pocketbook of Calculation in Stresses, etc., for Engineers, Architects and General Use. By R. Monson George. 16mo, pocket size. 140 pages. London..... $1 50

Stresses in Girder and Roof Trusses. For both Dead and Live Loads by simple multiplication, with Stress Constants for 100 Cases. For the use of Civil and Mechanical Engineers, Architects and Draughtsmen. By F. R. Johnson. As in a work of this kind accuracy is the first consideration, no effort has been spared to avoid errors. The Stress Constants have been, as far as possible, determined in two or three different ways, and the results compared. The signs + and = have also been very carefully checked. 215 pages. 28 plates. 12mo, cloth..... $2 50

Stresses. The Theory of Stresses in Girders and Similar Structures. With observations on the application of Theory to Practice, and Tables of Strength, and other properties of Materials. New revised edition, with numerous additions on Graphic Statics, Pillars, Steel, Wind Pressure, Oscillating Stresses, Working Loads, Riveting, Strength and Tests of Materials. By B. D. Stoney. 8vo. 777 pages. 143 illustrations and 5 folding plates..... $12 50

Structures. Theory and Practice in the Designing of Modern Framed Structures. By Johnson, Bryan, Turneaure. Third edition, revised and enlarged. Quarto, cloth..... $10 00

Surveying. A Handbook for Surveyors. By Mansfield Merriman and John P. Brooks. 12mo, morocco flap. 242 pages. N. Y., 1895..... $2 00

Surveying. The Theory and Practice of Surveying. Designed for the use of Surveyors and Engineers Generally, but especially for the use of Students in Engineering. By J. B. Johnson. Eleventh edition, revised and enlarged. 8vo, cloth. 754 pages. Illustrated. N. Y., 1895..... $4 00

Surveying. A Text-Book of Plan Surveying. By W. G. Raymond. 12mo, cloth. 485 pages. Illustrated. N. Y., 1896....$3 00

Testing of Materials of Construction. A Text-Book for the Engineering Laboratory and a collection of the results of experiment. By William C. Unwin. 8vo, cloth. 488 pages. Illustrated. London, 1888..... $7 00

Tramways; Their Construction and Working. Embracing a Comprehensive History of the System, with Accounts of the Various Modes of Traction, a Description of the Varieties of Rolling Stock, and Ample Details of Costs and Working Expenses. With Special Reference to the Tramways of the United Kingdom. By D. K. Clark, M. Inst. C.E., M. Inst. Mech. E. With over 400 illustrations. Thick 8vo, cloth. 780 pages..... $9 00

Tunneling. Practical Tunneling. Fourth edition, revised and greatly extended. With additional chapters illustrating recent practice. By D. K. Clark. With 36 plates and other illustrations. 8vo, cloth. London, 1896..... $12 00

Tunneling. Railway Tunneling in Heavy Ground. By Chas. F. Gripper. 8vo, cloth. 66 pages. Folding Plates. London, 1879..... $3 00

Tunnel, The Hudson River. Showing its Method of Construction. Carefully collected from Reliable Sources and from the author's Observations in the Tunnel. Thoroughly illustrated by the drawings of the engineers in charge. By S. D. V. Burr. 100 pages and 27 folding plates. 4to, cloth..... $2 50

Water Supply of Towns and the Construction of Waterworks. A Practical Treatise for the use of Engineers and Students of Engineering. By W. K. Burton. With numerous plates and other illustrations. Quarto, cloth. 304 pages. London..... $9 00

Weights. Tabulated Weights of Angle, Tee and Bulb Iron and Steel, and other information for the use of Naval Architects, Shipbuilders and Manufacturers. By Charles H. Jordan. Fifth edition, revised and enlarged. 580 pages, pocket form, morocco. London, 1896..... $3 00

Our large Catalogue of American and Foreign Scientific and Technical Books, embracing more than Fifty different subjects, and containing 116 pages, will be mailed, free, to any address in the world.

Any of the foregoing Books mailed, on receipt of price, to any address. Remit by Draft, Postal Note, Check, or Money Order, to order of

MUNN & CO.,
361 BROADWAY NEW YORK.

THE
Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.

PAGE

I. ARCHÆOLOGY.—The Parthenon.—The article describes the plans which have been adopted to restore this great monument.—1 illustration..... 17495

II. EDUCATION.—Sins of Modern Education.—A plea for greater liberty for children and of concentration of training upon the essentials..... 17504

III. GEOLOGY.—Limestone Formations.—An interesting note on limestone in mountains.—its character, and the vegetation produced on it.—1 illustration..... 17504

IV. MECHANICAL ENGINEERING.—A New Universal High Speed Steam Engine.—A peculiarly constructed engine specially adapted for high speed.—A machine of relatively few parts and of high simplicity of construction.—13 illustrations..... 17499

V. MEDICINE AND HYGIENE.—"Insusceptibility" to Vaccination.—Records casting doubt upon the theory that some cases are insusceptible to inoculation by vaccine lymph..... 17505
On the Use of Salicylate of Sodium and Bromide of Potassium in the Irritable Temper of Cardiac Diseases and Gout.—A very practical article on temper, its physical causes and medical treatment, for the relief of the patient and of those about him..... 17505
Oyster Culture in Relation to Disease.—By J. E. THORPE, in Nature.—An examination as to the possibilities of the dissemination of disease by oysters.—Investigation into the "coppery taste" of the bivalves..... 17501

VI. METALLURGY.—Notes on the Hydrometallurgy of Gold and Silver.—By W. GEORGE WARING.—An interesting paper on the new developments of the metallurgy of low grade gold and silver ores..... 17500

VII. MINERALOGY.—The Turquoise Mines of Persia.—Practical mineralogy.—The production of turquoise in the celebrated Persian mines..... 17500

VIII. MISCELLANEOUS.
Engineering Notes..... 17497
Electrical Notes..... 17497
Miscellaneous Notes..... 17497
Selected Formulæ..... 17498

IX. ORDNANCE.—On Certain Physical Difficulties in the Construction of Large Guns.—A valuable article on modern ordnance and the overcoming of accidents in the shrinkage process..... 17496

X.—PHYSICS.—Electrical Science and the Mystery of Phosphorescence.—A popular review of the present aspect of this mysterious phenomenon, with notes on the substances producing it..... 17505

XI. SANITARY ENGINEERING.—Merryweather's Pneumatic Cesspool Emptying Apparatus.—An apparatus for removing refuse inoffensively.—1 illustration..... 17505

XII. TECHNOLOGY.—The Longleaf Pine and the Naval Store Industry.—By CHARLES MOHR, Ph.D.—The naval store industry.—Tar, turpentine and resin.—How produced and how the raw sap is treated after collection.—4 illustrations..... 17502
The Resistance of Pneumatic Tires to Rolling.—Scientific examination of pneumatic tires and of the resistance to propulsion offered by them under different conditions.—1 illustration..... 17498

SPECIAL ANNIVERSARY NUMBER

of the SCIENTIFIC AMERICAN, containing eighty illustrations and a resumé of fifty years of progress in fifteen branches of science. 72 pages. Single copies, 25 cents, sent by mail in United States, Canada, and Mexico. Foreign countries 8 cents extra.

MUNN & CO., 361 Broadway, New York.

CATALOGUES.

A Catalogue of Valuable Papers contained in SCIENTIFIC AMERICAN SUPPLEMENT during the past ten years, sent *free of charge* to any address; also, a comprehensive catalogue of useful books by different authors, on more than fifty different subjects, has recently been published, for free circulation, at the office of this paper. Subjects classified with names of authors. Persons desiring a copy have only to ask for it, and it will be mailed to them. Address

MUNN & CO., 361 Broadway, New York.

BUILDING EDITION
OF THE
SCIENTIFIC AMERICAN.

Those who contemplate building should not fail to subscribe.

ONLY $2.50 A YEAR.

Each number contains elevations and plans of a variety of country houses; also a handsome

COLORED PLATE.

MUNN & CO., 361 Broadway, New York.

PATENTS!

MESSRS. MUNN & CO., in connection with the publication of the SCIENTIFIC AMERICAN, continue to examine improvements, and to act as Solicitors of Patents for Inventors.

In this line of business they have had *nearly fifty years' experience*, and now have *unequaled facilities* for the preparation of Patent Drawings, Specifications, and the prosecution of Applications for Patents in the United States, Canada, and Foreign Countries. Messrs. Munn & Co. also attend to the preparation of Caveats, Copyrights for Books, Trademarks, Reissues, Assignments, and Reports on Infringements of Patents. All business intrusted to them is done with special care and promptness, on very reasonable terms.

A pamphlet sent free of charge, on application, containing full information about Patents and how to procure them; directions concerning Trademarks, Copyrights: Designs, Patents, Appeals, Reissues, Infringements, Assignments, Rejected Cases. Hints on the Sale of Patents, etc.

We also send, *free of charge*, a Synopsis of Foreign Patent Laws, showing the cost and method of securing patents in all the principal countries of the world.

MUNN & CO., Solicitors of Patents,
361 Broadway, New York.

BRANCH OFFICES.—No. 622 and 624 F Street, Pacific Building near 7th Street, Washington, D. C.

The Scientific American Supplement. Index for Vol. 42.

JULY–DECEMBER, 1896.

The * Indicates that the Article is Illustrated with Engravings.

A

Acetylene as an illuminant *17138
Acetylene carriage, automobile *17116
Acetylene explosion, Paris *17415
Acetylene gas apparatus *17294, *17315 *17328, *17350
Acetylene gas on cars 17277
Acetylene lamp, new *17306
Acid phosphate solution 17267
Acid, sulphuric, purification 17277
Acne, lotion for 17196
Acoustics in medicine *17237
Actinograph, the 17122
Africa, the Romans in *17097
Afterglow, Alpine 17225
Air bath, the *17296
Air tester, an 17149
Albumen, blood, bleaching 17138
Alcohol, freezing point 17457
Aldehyde, formic, test for 17441
Ale, ginger 17340
Alkali works, generators for *17416
Alloys, aluminum, some 17181
Aluminum, alloys of 17181
Aluminum amalgam 17433
Aluminum for passenger cars 17467
Aluminum for sea vessels 17121
Aluminum printing plates 17266
Aluminum, sodium in 17214
Aluminum utensils, army 17104
Ambergris, mystery of 17427
Ambrosia sirup 17302
Ammonia, anhydrous, pressure 17120
Ammonia, household 17267
Amycose 17302
Andree, Doctor *17260
Ankle joint in man 17156
Animals, coloration in 17224
Animals, effect of heat upon 17448
Animals, pelagic, influ. light 17364
Animals, wild, tamers of *17306
Ant destroyer 17148
Anthropology at Brit. Assoc. 17432, 17451
Antiseptics, practical 17196
Aphis, spray for 17205, 17219
Aquarium cement 17340
Archæological remains, Arizona *17176
Archæology, Michigan 17321
Architecture, Græco-Phœnician 17167
Armature, three-phase motor 17218
Armenia and its patriarch *17434
Armies of the world 17153
Army, the Swiss 17181
Army worm, the *17282
Arrows, Bushmen's 17169
Art, European, prehistoric 16449
Arts and recipes, lost 17313
Asafœtida plant *17370
Asbestos deposit, Georgia 17357
Association, British 17336
Atomic theory, history of 17269, 17280
Audiometer, Henry's *17238

B

Bacilli, prophecies of 17448
Baling press, self-filling *17162
Balloon and submarine boat *17400
Balloon house, Spitzbergen *17261
Ballooning experience, fearful 17356
Balloons, army, experiments 17421
Balloon voyage, the longest 17277
Banana cream 17302
Banana sirup 17302
Bath, air, the *17296
Baths, hypo 17412
Baths of Lamalou *17191
Battery, electric, small *17107
Bedbug destroyer 17148
Beer, production, Germany 17197
Beer, root, recipe for 17120
Beer, spruce 17324
Beers, non-excisable 17276
Bell ringing on street cars 17314
Belleek china 17292
Belt, a monster 17149
Belts, carrying, use of *17152, *17163
Belts, how to clean 17218
Belts, to prevent slipping 17253
Benzine emulsion 17441
Benzine, to color red 17377
Bessemer process, history *17454
Betel chewing *17227
Beverages, summer 17313
Bicycle, a family *17263
Bicycle in the army *17358
Bicycle mechanics *17212
Bicycle tire cement 17105
Bicycle vibrations, recording *17212
Bicycles, primitive *17417
Birds, flight of 17435
Birds, migration of 17305
Bismarck, statue of *17189
Black, dead, for iron 17180
Blackboards, composition for 17412
Blasting tests 17181
Bleaching, art in 17392
Blood spitting, treatment of 17126
Blotter substitute 17313
Blower, compound *17161
Boats, machine for warping *17115
Body as shown by X rays *17334
Boiler coverings, tests of 17413
Boiler explosions, U. S., 1895 17132
Boiler furnace, Wegener's *17162
Boiler, the Strong *17418
Boilers, Pompeiian *17486
Boilers, steam, corrosion 17181
Bolivia, Indians of *17427
Book edges, marbling *17390
Book indexing system 17473
Bookbinders' cloth, gloss for 17327
Borax in butter, detect 17472
Borings and turnings, foundry 17396
Bottle holder *17451
Bottles, drying 17472
Bounds, beating of the *17141
Boy, a lion faced *17412
Brains of the non-insane 17485
Brass, gilding of 17459
Brass polish 17133
Breech mechanism, automatic *17117
Brick, hollow 17121
Brick pavements, defects of 17440
Brickwork, durability, tests 17413
Bridge, arch, concrete *17402
Bridge, Wheatstone, inventor of 17197
Bridge, Yrtycle *17118
Bridges, iron, German, early 17384
Bridges, suspension, study of *17444
Briquettes, anthracite 17232
Briquettes, small coal 17397
British Association 17432, 17451
Bromine process for gold 17489
Bronze casting in Europe 17245, 17268 *17278
Brunig railway *17208
Brussels Exhibition of 1897 *17242
Brux, catastrophe at *17099
Building construction, Paris *17292
Bulbs, rubber, how made *17106
Butter, borax in, detection 17472
Butter, manufacture of *17122

C

Cab, motor, Booth's *17231
Cable laying on Amazon River 17139
Cables, wire, lubrication 17473
Caffeine, citrate, effervescing 17164
Calcium carbide, new process 17413
Calorimeter for ice examin *17285
Cambodia, ancient ruins in *17125
Camera, naturalist's *17318
Camera, surveying *17235
Canary bird food 17252
Canada, new districts in 17104
Candia, trouble in *17239
Candy, rock, coltsfoot 17396
Candle, a new 17396
Cane, electric *17107
Cape Grant and Bell Island *17320
Carbon, convers. into graphite *17215
Carbon, electric current from *17139
Carbon in steel, determination 17395
Carbon, pear, use of 17341
Carbon, the big *17309
Car, auto. military *17482
Car, auto. military 17253
Car, electric street cleaning 17197
Car, freight, load of 17165
Car seats, pivoted 17165
Carriage, acetylene, automobile *17116
Carriage, Booth-Crouch *17231
Carriage, gasoline, Vallee *17311
Carriage, horseless, race *17231, 17374
Carriage, road, petroleum *17182
Carriage, steam, Cugnot's *17183
Carriages, names of 17340
Cascade Mountain *17306
Castings, brass, removal cores 17254
Casting, bronze, in Europe 17245, *17278
Castings, cleaning 17197, 17302, 17311
Caterpillar, the tent *17436
Cat, luminous, the 17149
Cave dweller remains, Arizona *17176
Celebration, Hungarian *17127
Cement, aquarium 17340
Cement, bicycle tire 17105
Cement, diamond 17377
Cement for hot water pipes 17340
Cement for kerosene lamps 17340
Cement for leather 17377
Cement for mineral oil 17340
Cement for porcelain 17180
Cement for porcelain letters 17302
Cement, Portland, tests of 17165
Cement, steam tight 17340
Cement to join iron and stone 17340
Century, next, beginning of 17482
Cesspool apparatus, pneumatic *17505
Chains and chain iron *17264, *17273
Characters, acquired, inheritance 17158
Charlotte russe 17302
Chat of 1846 with 1896 17168
Chemistry, history of 17147
Chewing gum 17156, 17420
Chicle gum 17156
Chilblains, remedy for 17459
China, Belleek 17292
Chlorine, manufacture 17302, 17403
Chocolate sirup 17302
Chrom-ammonium salts 17485
Chronograph, Smith's *17460
Cider, orange 17324
Cider preservatives 17459
Cider, quince 17324
Circuit breaker, a large 17253
Clam bouillon 17324
Clam juice shake 17302
Clearing solution 17313
Clocks, Renaissance *17359
Clocks with automatons *17272
Cloth and glove cleaner 17267
Clouds, notes on 17145
Coal, coking power of 17149
Coal mine wages, Prussia 17472
Coal oil in flushing urinals 17132
Coal product, American 17100
Coal, spontaneous combustion 17165
Coal, value of a pound 17376
Coals, Indiana 17132
Coasts, our, defense of 17188
Cochineal cultivation 17491
Cockroach exterminator 17317
Coffee sirup 17302
Coil, high frequency, construct *17377
Coins, American, alloys of 17376
Coins, Chinese 17397
Coins, English *17243
Coins, Greek, sale of 17254
Cold saw machine *17401
College, the oldest 17430
Collodion films, wet, transfer 17355
Collodion, process work 17472
Color, causes of 17388
Color in plants, physiology 17171
Color, preserv. in specimens 17450
Colors named in literature 17289
Coloration in animals 17224
Columns, steel and iron, tests 17458
Composing machine, Lanston 17399
Composition, typographic, trans 17440
Compounds, organic, freezing 17457
Concierges, Parisian 17132
Condiment, the national 17435
Conductivity, electrolytic 17473
Converter, Bessemer, history *17454
Copper, electrolytic, refining *17347
Copper, to gild 17459
Copying pad material 17459
Core prints *17345
Cores, removal from castings 17254
Corn cures 17105
Cosmetic powder 17412
Cough drops, Montpellier 17324
Cough sirup 17412
Crane, gantry, 200 foot *17468
Crane, railway, automobile *17135
Crane, steam, improved *17344
Crete, trouble in *17239
Cripple Creek 17192
Crucibles, laboratory 17376
Cruiser Doris *17111
Cruiser Russia 17132
Crystals, hollow 17139
Current motor, Austin *17263
Currents, electric, measurement 17110
Curry powders 17219
Curtius, Ernst *17230
Curtains, lace, to wash 17405
Cutters, milling, speed of 17376
Cycle mechanics *17212
Cycling, primitive *17417

D

Dahrnenite, explosive 17397
Dairy show, the *17451
Dam, Rock River *17351
Danube, opening of the 17384
Date crop, Persian 17121
Democracy, industrial 17244
Depilatory, new 17276
Depilatory, a safe 17261
Detartarizer boiler *17354
Dextrine mucilage 17405
Diamond, the largest *17309
Diamonds from steel *17477
Diego-Suarez, colony of *17342
Dielectrics, note on 17191
Diffraction gratings 17352
Direction, how to find one's 17430
Diseases of Arctic circle 17262
Disincrustant, boiler *17354
Disinfectant, bermitine as 17233
Disinfectant, sick room 17196
Dock, pontoon, floating, new 17140
Doors, watertight, closing 17253
Doris, cruiser, British *17111
Drachenfels railway *17209
Drachenfels, the *17210
Drawings, alteration in 17488
Dredger, electric *17310
Dredgings, deep sea *17225
Drill boats on Danube *17386
Drills tempered by electricity 17233
Drunkenness, hereditary 17104

E

Earth, rotation of the 17125
Earwax, to soften 17219
Education, engineering 17229
Education, modern, signs of 17504
Education, scientific, foreign 17381
Egg cream 17313
Egg phosphate 17302
Egypt, excavating in 17488
Electric apparatus, new *17107
Electrical notes 17104, 17121, 17132, 17149 17165, 17181, 17197, 17218, 17233, 17253 17266, 17277, 17301, 17314, 17325, 17341 17357, 17376, 17397, 17413, 17421, 17440 17458, 17473, 17484, 17497
Electricity in the theater *17381
Electrolyzer, new 17218
Electro photography *17107
Electroscope, a three-leaved 17307
Elephants, capture in Siam *17322
Elmwood, Cape Flora *17320
Emery, convers. into corundum 17132
Enamel, baking *17212
Engine, gas, Crossley *17247
Engine, oil, for launches *17106
Engine, steam, high speed, new *17409
Engine, traction, compound *17161
Engine, triple expansion, new 17397
Engines of torpedo boats *17439
Engines, paddle, English *17150
Engines, portable, at Leicester *17159
Engines, steam, of the world 17253
Engines, traction, oil *17442
Engineering and science 17100
Engineering, artistic element 17311
Engineering education 17228
Engineering notes 17104, 17121, 17132 17149, 17165, 17181, 17197, 17218, 17233 17253, 17266, 17277, 17301, 17314, 17325 17341, 17357, 17376, 17397, 17413, 17421 17440, 17458, 17473, 17484, 17497
Engraving by fire *17202
Engraving, wood, as a fine art 17200
Entomologist, young, wants of 17240
Envelopes, X ray proof 17358
Erythronium, the genus *17414
Essay, prize 17168
Essay, prize, competition 17198, 17219 17236
Essence of crab apple blossom 17441
Etching on glass 17356
Etching on steel 17232
Etching of wood 17340
Ethnology, Bureau of 17489
Exhibition, Brussels *17242
Exhibition, laundry *17316
Exhibition of German colonies *17198
Expedition, polar, Andree *17260
Exploration, Arctic, Nansen's 17492
Explosive, mining, new 17397
Explosives, power of 17413
Eye, black, treatment of *17276
Eyes, measuring for glasses *17205

F

Fabrics for photo. printing 17157
Fabrics for tires, manufact 17201
Fabrics, some new 17418
Fakirs, sleeping, Budapest *17187
Fats, rancidity of 17450
Fayum, dead cities of 17155
Feculometer, the *17295
Ferula fœtida *17370
Field glass, improved *17345
Filaments, electric, temperature 17104
Films, wet, transferring 17355
Finger print indexing 17314
Fire damp testing station *17297
Fires, colored, liquid 17133
Fireworks, novelty in 17133
Fish food, invisible 17217
Fish nets 17379
Fishes, deep sea *17225
Flashlight powder 17356, 17396
Flea destroyer 17148
Fleas and mosquitoes 17224
Flints, gun, manufacture 17458
Floors, paper pulp 17181
Flour sifter, pendulum *17113
Flour testing laboratory 17396
Flowers, coloring 17165
Flowers, frozen, Australian 17472
Flowers out of season, product 17277
Fluid, cleansing, new 17105
Flux, brazing, a good 17267
Flying machine, Stentzel's *17400
Fly paper, sticky 17216
Foam producer, soda water 17105
Food economy, errors in 17288
Food for canary birds 17252
Food, malted, for infants 17222
Food yield of an acre of land 17448
Force, centrifugal, experiment *17302
Forest preservation, Baden 17259
Formaldehyde gelatine 17148
Formulæ, selected 17105, 17120, 17133 17148, 17164, 17180, 17196, 17219, 17232 17252, 17267, 17276, 17302, 17313, 17324 17340, 17356, 17377, 17396, 17412, 17420 17441, 17459, 17472, 17485, 17498
Freaks, and disease of skin 17179
Freckles, remedy for 17105
Freckles, removal of 17459
Freight car loads 17197
Friction, fluid 17341
Frost bite remedy 17252
Fruit preservation, process 17120
Fuel, powdered, furnace for *17102
Fumigating paper 17396
Functions, human, interdepend 17476
Furnace, electric, Moissan's *17477
Furnace for heating tires *17103
Furnace, glass, open hearth *17251
Furnace powdered fuel *17102
Furnaces, electric *17215

G

Garden, botanical, Hong-Kong *17321
Gardens, botanical 17364
Garments, tapestry, of Incas 17405
Gas, acetylene, apparatus *17294, *17315 *17328, *17350
Gas conveyance by pressure 17197
Gas engine, Crossley *17247
Gas for lighting cars 17165
Gas from coal dust 17314
Gas lighter, automatic *17331
Gas mantle, new 17440
Gas motor tramcars *17210
Gasoline carriage, Vallee *17311
Gelatine, formaldehyde 17148
Generators for alkali works *17416
Giant, an American *17123
Gingerette 17340
Gilt, German, restoring 17180
Glass, black and smoked 17276
Glass, etching on 17356
Glass, frosted and figured 17252
Glass, plate, influ. on style 17472
Glass, plate, painting 17357
Glass, polished, thin 17316
Glassware, non-breakable 17314
Glassworks, furnace for *17251
Globe, terrestrial, great *17175
Glosses for leather workers 17327
Glove and cloth cleaner 17267
Glue, fish, liquid 17252, 17472
Glue, liquid 17105
Glue, liquid, Brand's 17219
Glue, marine 17472
Glue paste 17405
Goddaughter of the fairies *17154
Gold extraction from ores 17440
Gold, extraction of 17233
Gold extraction process 17281
Gold, hydrometallurgy of 17500
Gold mining, Johannesburg 17277
Gold process, Cassel-Hinman 17489
Gold, tarnished, restoring 17196, 17441
Gold yield of the world 17414
Goldenade 17313
Gooseberry, a new *17288
Gorilla, the *17224
Gout, soda salicylate in 17505
Granite, sources of supply 17111
Graphite, convers. of carbon 17132
Gratings, diffraction 17352
Guano, chemical 17352
Gum, chewing 17156, 17420
Gum, elastic, wealth based on 17393
Guns, high pressure in 17314
Guns, large, construction *17496
Guns, quick fire, French *17289
Gutta percha substitutes 17149, 17266
Gymnastics, medico-mechanics *17447

H

Hæmoptysis, treatment of 17125
Hæmostat, electric *17197
Hair, falling, remedy for 17120
Hair, gray, to darken 17120
Hair, to lighten 17120
Hair washes 17120
Half tone work, screeny effect *17270
Heart disease, soda salicylate 17505
Heat and light, chemical action 17190
Heat, cost of 17181
Heat, effect upon animals 17449
Heater detartarizer, Chevalet *17354
Heater, electric, oil well 17314
Heavens, depths of *17438
Hektograph mass 17120
Helium, liquefaction of *17200
Helium, non-liquefiable 17395
Hell's Gate, Beaver Canon *17393
Herbarium, hints for the 17196
Hermitine as disinfectant 17233
Hong Kong *17320
Hook, suspension, automatic *17441
Hospital system, railway 17349
Hospitals, electric light in 17104
House, a remarkable *17481
House made of paper 17440
Houses, city and suburban 17471
Hub forming lathe *17183
Hungary, millennium of *17127
Hydro-extractors, water-driven *17316
Hydrogen cylinders, exploded 17450
Hydrogen peroxide as a bleach 17218

I

Ice making machine, simple *17327
Ice, sanitary analysis of *17285
Ichthyol, odor, to mask 17412
Images, monochromatic and phot 17205
Indians, Bolivian *17427
Indicator, a novel *17254
Indicator, Watts-Tabor *17344
Indurite 17341
Industry and intellectual devel 17459
Ink, diamond 17356
Ing for writing on glass 17412
Ink, hektograph 17459
Ink, manufacture of 17157
Ink, to preserve 17219, 17441
Inks for rubber stamps 17441
Ink, typewriter 17196
Inscription, Prof. Petrie's 17179
Insecticides 17148
Insects injurious to grain *17410, *17428
Insects, shade tree 17492
Instruments, surgical, rusting of 17158
Invention, progress (essay) 17168, 17187 17198, 17219, 17236
Inventions, seventeenth century *17114
Inventions, successful 17277
Iron boride 17181
Iron, effect of pickling 17393
Iron Gate, blasting of the 17366
Iron industry in Russia 17233
Iron mining, modern methods of 17252
Iron ore industry of U. S 17172
Iron, removal of from water 17457
Iron work, cleaning 17393

Ivory, how to bleach 17396
Ivy, Japan, action on walls 17139

J

Jackson in White North *17319
Jacks o' the clock *17272
Japan, cheapest labor of 17371
Japan, progress in 17394
Joints, welded, strength of 17357

K

Ketchup, tomato 17435
Kitchen, royal, at Windsor *17435
Kite, Weather Bur au. *17108
Koptos, ruins of 17156
Krupp works, the 17302

L

Label, gum 17405
Laces, cleaning and dyeing 17405
Lælio-Cattleya *17343
Lake Capais, drainage of 17165
Lakes, the great, history of 17398
Lakes, the great 17142
Lamalou, baths of *17191
Lambesis, pretorium in *17008
Lamp, acetylene, new *17396
Lamp, incandes., voltage of 17253
Lamp, electric, portable *17107
Lamp, safety, new 17218
Lamp, the Denayrouse *17296
Lamps, electric, note on 17223
Lamps, incandes., exhaustion 17314
Lantern, photo., portable *17318
Lantern slides by reduction 17297
Lantern slides, display app *17295
Lathe attachments, new *17387
Lathe, facing and boring *17375
Lathe, hub forming *17183
Latitudes, influence of currents 17098
Launches, oil engine for *17103
Launching vessels in France *17265
Leather, cement for 17377
Leather dressing 17148
Leather, glosses for 17327
Leather, polish for 17232
Leather restorer 17327
Lemonade, egg 17392
Lemons, preservation of 17489
Lepers in Europe 17165
Lever construction 17149
Library, wooden, German 17301
Life, temperature limit of 17485
Light and heat, chemic. action ..... [illegible]
Light, electric, vs. the eyes 401
Light, the coming *17296
Lighter, gas, automatic *17381
Lighthouse engineering 17301
Lighting, electric, car *17184
Lighting, electric, hospitals 17104
Lighting, electric, Tesla syst 17104
Lightning arresters 17280
Lightning, globular 17325
Lightning strokes in cities 17376
Li Hung Chang *17255
Li Hung Chang and Bismarck *17170
Li Hung, trip of *17393
Limestone formations *17504
Lime tablets 17376
Limes, preservation of 17489
Liniments, soothing 17356
Lion faced boy *17412
Liquids, viscosity of 17485
Locomotive, Australian *17159
Locomotive, life of 17165
Locomotive, rack railway *17307
Locomotive, Santo Domingo RR. *17210
Locomotive, the Strong *17418
Locomotives, oil *17442
Locomotives, rack rail *17464
Locomotives, road, at Leicester ..*17159
Lubricant for shells 17218
Lubrication of bearings 17325

M

Machinery polish 17133
Mackerel capturing device 17431
Magazines for the blind 17397
Magnesia, sulph., effervescent 17164
Magnet a new 17165
Magnet, effect on human organ 17121
Magnetism at low temperatures 17169
Man, largest in world *17123
Mantle, gas, new 17440
Mantles, incandescent 17397
Maple sugar 17317
Marbling book edges *17390
Massais, types of the *17198
Matabeleland *17143
Matches, production, phenomenal ..17197
Matches, safety 17148
Mead of Math 17324
Meat, smoking 17396
Medicine and pure science 17332
Mekong mission *17124
Men, civilized, oldest *17256
Mercury, proctannate of 17430
Metal and timber, strength of 17357
Metal polishes 17133
Metal polishing paste 17302
Metal, sheet, punching 17413
Metal work, cleaning cavities 17211
Metals, analysis by electrolysis ..*17248
Metals floating in liquids 17373
Metals, solution in mercury 17121
Metals, white, for wearing surf 17314
Meters, electricity, status of 17218
Meters, vibrations *17116
Metric system in Russia 17306
Mexico, products of 17436
Micro-organisms, transmission of ..17146
Milk adulterants 17357
Milk and its products 17249
Milk, condensed, manufacture ..*17185
Milk, electrolysis of 17473
Milk investigation, recent 17395
Milk, malted 17439
Milk, pasteurized 17261
Milk punch sirup 17313
Milk sterilizer *17451
Milling machine, test piece *11115
Milling machines, improved *17151
Mining, Phœnician 17449
Mirror, the largest, in U. S. 17396
Miscellaneous notes ..17104, 17121, 17132, 17140, 17165, 17181, 17197, 17218, 17233, 17266, 17277, 17301, 17314, 17325, 17341, 17357, 17376, 17397, 17413, 17421, 17440, 17458, 17473, 17484, 17497
Mite exterminator 17313
Monkeys, how trained *17095
Monotype machine, Lanston's ..*17399
Monument, Emperor William ..*17167
Monocle, electric *17107
Moon, life in the 17378
Mordants, some valuable 17450
Morocco, gloss for 17327
Mosquito oil 17148
Mosquitoes and flens 17224
Mother of pearl, imitation 17396
Moth, codling, remedy against 17180
Moth, tussock, the *17194
Motor, current, Austin *17268
Motor, Daimler, tramcar *17134
Motor, electric, centrif. pump ..*17457
Motor, gas, tramcar *17210
Motor, hot water 17197
Motor, oil, for launches *17103
Motor, road, De Dion & Bouton ..17263, *17290
Motors, compressed air 17473
Motors, electric, German *17395
Mount Stephen, Canada *17303
Mucilages and pastes 17405
Mucilage cakes 17196
Mucilage, preservation of 17356
Museum, Egyptian, new 17175
Museum specimens, color preserv ..17450
Museum, the British 17096
Music registering apparatus *17317

N

Nail cleaning liquid 17180
Nails, wire and cut, tests of 17375
Nansen in White North *17319
Nansen, achievements of *17234
Naval store industry *17303
Navy, German, sickness in 17494
Negroes, history of 17398
Nickel, electro deposit 17232
Nickel plating of wood 17270, 17402
Nipples, rubber, how made *17106
Neptune, jubilee year of 17323, 17343
Nets, fish 17379
Newfoundland, development of ..17221
Newspaper wrappers, automatic ..17463
Notes, Bank of England 17197
Nozzles, exhaust, experiments 17397

O

Oatmeal powder 17340
Observatory at Meudon *17307
Observatory at Paris *17307
Odometers *17274
Oil engine for launches *17103
Oleomargarine as medicine 17130
Ombu, the *17228
Omnibus, steam, Scotte's *17467
Opera glass, improved *17345
Orange phosphate 17302, 1737:
Oranges, preservation of 17489
Orchid, hybrid, new *17343
Oxygen for inhalation 17420
Oyster culture, and disease 17501
Ozone generator, new 17473
Ozone, preparat., new method 17218
Ozonizing apparatus, new *17130

P

Paints, gold and bronze 17133, 17472
Palm, betel *17227
Palm, dwarf, fiber of 17121
Paper, electricity in 17458
Paper, fireproof, new 17277
Paper, fly, sticky 17216
Paper, fumigating 17396
Paper houses 17440
Paper, lightning 17133
Paper paste 17405
Paper, "pole" 17472
Paper pulp floors 17181
Papers of world, circulation 17341
Parchment paste 17405
Parthenon, preservation of *17495
Paste, elastic 17196
Paste, library 17164
Pastes and mucilages 17405
Patent statistics of England 17197
Patents, British, statistics of 17458
Patriarch, Armenian, new *17434
Pavements, brick, defects of 17440
Pavements, yellow pine 17376
Pencils, gelatine, medicated 17138
Pepsin and bismuth 17164
Pepsin, effervescent 17164
Peach-blow sirup 17313
Perfumes, action of light on *17398
Petroleum adulteration 17121
Phœnicia, mining in 17449
Phonendoscope, Bianchi's *17257
Phosphorescence, mystery of 17505
Photography, color 17133
Photography, electro *17107
Photography for chemists 17297
Photography, telescopic *17217
Photogravure, first experiment 17105
Photo-electrical experiments 17149
Photometer for X rays 17110
Physics without apparatus *17302
Pickling iron and steel 17309
Pilatus railway *17208
Pine, long leaf *17490
Pipes, drain, jointing 17363
Planimeter, the hatchet *17230
Planing machine, improved *17336
Plant color, physiology of 17171
Plant colors, to preserve 17226
Plant structure and X rays 17110
Plate development, wholesale 17356
Plate, photo., speeds 17122
Plates, photo., packing 17494
Platinum, primitive production 17253
Plessimeter, the *17237
Polish for metals 17302
Polish, colored, for leather 17232
Polish, japan, to restore 17210
Polish, nail 17180
Polishes for metals 17133
Pomade, cucumber 17252
Pompeii, discoveries at 17170
Population, European, growth 17187
Population, urban, of U. S. 17473
Postage stamps, note on 17218
Postal card machines 17341
Potassium brom., effervescent 17164
Potassium, chloroplatinite 17267
Potential, fall of, on circuit 17397
Powders, smokeless, tests of *17460
Press, baling, self-filling *17162
Pretorium in Lambesis *17008
Printing, photo., on fabrics 17137
Prints, gelatine, glazing 17313
Prints, paper, fixing 17275
Projectiles, velocity, measuring ..17376
Psychology, the new 17453
Pulp business, largest 17222
Pulp, wood, preservation of 17122
Pump, centrifugal, motor for *17457
Pump, salvage, yacht *17103
Pumps, feed, for boilers *17465
Punching and shearing 17209
Pygmies, Indian *17476
Pyrochromy *17202

Q

Quicksand accident due to *17009
Queen Victoria, anniversary *17336

R

Railroads, Japanese 17182
Railway, Chinese, first *17304
Railway construction in U. S 17253
Railway crane, automobile *17135
Railway lines in France 17197
Railway, mountain, Snaefell *17247
Railway speed, highest 17277
Railway trains, electric light 17248
Railway, transsiberian *17118
Railway plant, electric model *17406, *17423
Railway, underground, N. Y *17424
Railways of Argentina 17376
Railways, British, lengths of 17440
Railways, light, good 17401
Railways, electric, of Europe 17413
Railways of France 17357
Railways of India 17357
Railways, rack *17207
Rainbow effect on cloth 17197
Rays, X, effect on hands 17426
Rays, X, diffraction of 17126
Rays, X, in analytical research 17120
Rays, X, new apparatus for *17254
Rays, X, on electrized bodies 17190
Rays, X, photometer for 17110
Rays, X, polarization of 17148
Rays, X, recent researches ..17109, *17173
Rays, X, solar, on Pike's Peak 17476
Refrigerating machine, new *17406
Registering apparatus, Michelin ..*17408
Rennet, liquid 17420
Resistance box, self-testing *17475
Respirator, a new 17373
Returns, ground, cheap 17341
Rhododendron Smirnowii *17171
Richardson, Sir Benjamin W *17450
Rigi railway *17207
Ring, fixed, to remove 17252
Rings, rubber, how made *17106
Rivet heads, removal of 17421
Road, underground, New York ..*17424
Roads, good, by bad men *17471
Rocks, foldings of the 17225
Ropes and belts, experiments on ..17121
Ropes and belts, power absorp 17458
Romans, the, in Africa *17097
Rowboat trip, N. Y. to Havre *17291
Rubber, Para, production of 17458
Rubber stamps, how made 17185
Rubber sundries, how made *17106
Rubber, to preserve 17441
Rubber, wealth based upon 17303
Ruins of Koptos 17156
Ruins of Nhon-To *17125
Ruins, Roman, in Africa *17096
Russia, cruiser 17132

S

Sails, perforated 17421
Sake, Japanese 17266
Sandblast to clean castings 17202
Santa Fe and Foudroyant *17479
Soporific, a new 17165
Sardine fishing industry 17193
Sauce, liquid 17430
Sauce, thick 17412
Sauce, Worcestershire 17430
Saws, hand, to file 17226
Scalp, wash for 17130
School gardens in Russia 17306
School, industrial, Germany 17195
Schools, horticultural, Belgium 17123
Schools of ancient Greece *17233
Science and engineering 17100
Scurimobile *17443
Sea frontiers, our, defense 17188
Seasickness, to prevent 17430
Seasons, periodicity of 17360
Sea, what it has taken 17289
Seismograph, bicycle *17212
Seismograph, Milne's *17116
Selenium, resist. to X rays 17109
Separator, centrifugal, new *17122
Sewer, Clichy, new *17150
Sewers of Paris, visiting the *17250
Sewing machine in Turkey 17397
Shade tree insect problem ..*17178, *17194, *17220
Shaft governor for engines *17160
Shampoo liquid 17196
Shaving preparation 17396
Shell fish, preserving 17357
Shearing and punching 17209
Shearing machine, improved *17214
Sheepskins, tanning 17219
Shingles, white cedar 17397
Ship canal, Harlem River 17473
Ship models, experiments with ..*17275
Shipping, waste of 17291
Ships, war, German, design of ..*17135
Shoes, heatable 17421
Shutter, focal plane *17459
Sifter, pendulum, Carter's *17113
Sight, second 17477
Signaling apparatus, night 17132
Signaling with ships 17357
Silk made from wood 17256
Silk, stamping of 17138
Silver, hydrometallurgy 17500
Simon, Jules *17131
Sirups, soda water 17302, 17313
Silver, electrolytic, refining *17347
Silver, to gild 17459
Skeleton, X ray *17384
Skin, chapped, ointment 17340
Skin diseases and freaks 17179
Skins, small, preserving 17416
Sleight of hand experts 17488
Smoke prevention 17376
Smokers, sore mouth of 17219
Snails, edible, in Europe 17177
Snuff, effects upon the system 17448
Soap milk for cleansing 17441
Soap, soda, in wool washing 17233
Soap, soft, as lubricant 17238
Soap stock 17440
Soap, tobacco 17232
Soaps, industrial 17480
Soda water foam producer 17105
Sodium in aluminum 17214
Soldiers, rations of 17357
Solutions, solid 17238
Soudan, campaign in *17119
Spark discharges and light 17413
Speed control in steamers 17112
Sphygmometrograph, the *17426
Spiders, notes on 17300
Spiders, some interesting *17339
Stage, revolving, new *17230
Statue, electrolytic copper *17140
Statue of Bismarck *17189
Statesmen, veteran, two *17170
Stamps, rubber, how made 17185
Steamer Southend Belle *17150
Steamers, speed control in 17112
Steamers, turret deck *17463
Steam power of Germany 17325
Steam trap, new *17213
Steel and iron, hysteresis of 17165
Steel, carbon in, determinat 17395
Steel construction, influence of 17472
Steel hardening by cyanide 17301
Steel, effect of pickling 17203
Steel polish 17133
Steel process, Bessemer *17454
Steel work, blacking 17180
Stitch, surgical, interrupted *17332
Stones, precious *17298, *17332
Stars, motion in line of sight 17449
Strings, revolving vibrations *17141
Sugar in urine, test for 17324
Sugar, maple 17317
Sugar, test for 17148
Sugars, to distinguish 17267
Surgery, mediæval 17238
Sulphur industry of Sicily 17104
Suppositories, glycerin 17180
Sun, eclipse of at Vadso 17241
Sunstrokes 17250
Sun symbols in Egypt 17176
Surveying app., act'n electricity 17214
Surveying, camera for *17235
Swan, black necked *17259
Syndeticon, fish glue 17232

T

Table sauce 17430
Tablets from Nippur *17258
Tapestry, Gobelins *17154
Tamers of wild animals *17306
Tan, removal of 17459
Tarawai, village of *17198
Tattoo marks 17232
Teeth extraction, painless 17377
Telephone line, the longest 17421
Telephones, military 17277
Temperature, high, measurement ..17301, 17426
Test specimens, preparation of ..*17115
Thamugadi, a street in *17098
Theater, electricity in *17331
Theater, exposition of 17266
Theater, Roman, Thamugadi *17098
Theater stage, revolving *17230
Thermo-elements of amalgams 17458
Thirst, relief of 17232
Thirst, remedy for 17377
Thunderstorms, Italian 17222
Tiara of Saitapharnes *17145
Tiles, wood pulp 17232
Timbuctoo *17367
Tin plate industry of U. S. 17301
Tires, apparatus to heat *17109
Tires, bicycle, cement for 17105
Tires, fabrics for 17201
Tires, pneumatic, cells for *17246
Tires, pneumatic, origin of *17231
Tire, pneumatic, Valire *17311
Tobacco habit cure 17340
Toilet cream 17340
Tools in ancient Greece 17416
Tomato ketchup 17435
Toothache drops 17313
Tooth paste, eucalyptus 17396
Toothpick industry, large 17397
Toothpicks, natural 17181
Tooth powders 17276
Torpedo boat engines *17439
Torpedo boat Viper *17388
Towers, mysterious 17429
Traction systems, Europe 17183
Train, fast, German 17376
Train loads, average paying 17218
Trains, electric lighting of 17248
Tricycle, automobile, Bollee *17115
Trap, steam, new *17213
Tramcar, Daimler motor *17134
Tramcars, gas motor *17210
Tramway, electric, Lugano *17267
Tramways, electric, of Europe 17165
Transformers, alternate current ..*17330, *17346, *17360, *17408
Tree in Dakotan rites 17241, 17257
Trees, gigantic *17226
Trichopilia coccinea *17438
Trick, a simple and effective 17477
Tubes, Crookes, mechan. action 17148
Tubes, Crookes, max. power of 17174
Tubes, metallic *17186
Tubing, rubber, how made *17106
Tubes, glass, how made 17157
Tunnel, Boston water works 17421
Turquoise mines, Persia 17503
Turret deck steamers *17463
Turret, electric *17310
Tussock moth, the *17194

U

Uranium, properties of 17346

V

Vaccination, insusceptibility to 17505
Valve, safety, Genard's *17355
Valve seats, facing *17135
Vanilla, extract of 17164
Varnishes, bookbinders' 17328
Varnish, patent leather 17324
Vaselin, purity, test of 17377
Vegetation versus light 17177
Velocipede, water *17443
Velometer, Dumon's *17387
Vessel, swiftest in world 17376
Viaduct, Prussian, a lofty 17421
Vibrations, arresting *17280
Vibrations, app. to eliminate *17443
Vibration meters *17116
Vichy salt, effervescent 17164
Victoria, Queen, anniversary *17336
Viper, torpedo boat *17388

W

Wave, tidal, in Japan *17431
Wart remedy 17196
War, new implement of *17482
War vessels, German, design *17135
Watch, the, vs. compass 17430
Watches, some curious *17474
Water bottles, rubber *17107
Water, hot, for the public 17277
Water, hot, pumping 17272
Water, hot, remedial effects 17313
Water, machine for raising *17387
Water, machine to raise *17114
Water, potable, iron in 17459
Water raising machine, ancient ..*17246
Waves, electric, transmission 17376
Waves, tidal, in Japan *17371
Wax, ear, to soften 17219
Weather Bureau kite *17108
Webworm, fall *17220
Welding, electric 17165
Welding, note on 17121, 17132
Whales killed electrically 17149
Wheel, cast iron, largest 17376
Wheel, water, Pelton *17374
White lead, by electrolysis 17186
Wire, effect of sulphur on 17121
Wire, fine, manufacture of 17197
Wire, fine, value 17266
Wire, the finest 17165
Wild cherry phosphate 17377
Wine production of world 17301
Wine, unfermented 17441
Wood and metals, strength of 17412
Wood, nickel plating 17402
Wood pulp, separation of 17122
Wood working for amateurs *17329
Worcestershire sauce 17430
Works of an enemy, destroying ..*17403
Worlds, other, habitability 17411
Worm, the army *17282
Wrapping machine 17463

Y

Yacht Standart, pump for *17103
Yews, English, aged 17376
Yrtyche bridge *17118

Z

Zanzibar *17287
Zanzibar, bombardment of *17483